ABSTRACTS OF NORTH AMERICAN GEOLOGY

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UNITED STATES DEPARTMENT OF THE INTERIOR
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GEOLOGICAL SURVEY

William T. Pecora, *Director*

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports of memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

The numbers assigned to the abstracts in this publication are for reference in using the index; they are not order numbers. Publications cited here in abstract form are available in most geological libraries or through interlibrary loan.

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A list of journals commonly cited in Abstracts of North American Geology may be obtained by writing to the U.S. Geological Survey, Washington, D. C. 20242. Serial publications cited for the first time are as follows:

Annales Spéléologie—Annales de Spéléologie. Centre de la Recherche Scientifique. Paris, Franec.

Gulf Coast Assoc. Geol. Socs. Spec. Pub.—Gulf Coast Association of Geological Societies Special Publication. New Orleans, La.

Jour. Range Management—Journal of Range Management. American Society of Range Management. Denver, Colo.

Jour. Remote Sensing—Journal of Remote Sensing. A publication of the International Remote Sensing Institute. Sacramento, Calif.

Physics and Chemistry Glasses—Physics and Chemistry of Glasses. Society of Glass Technology. Sheffield, England.

Texas Univ. Austin Bur. Econ. Geology Geol. Quad. Map—University of Texas at Austin Bureau of Economic Geology Geologic Quadrangle Map. Austin, Tex.

The abstracts in this issue were prepared by Arthur P. Butler, Jr., James W. Clarke, Georgianna D. Conant, Howard R. Cramer, George H. Dixon, Raymond C. Douglass, Richard E. Grant, Elizabeth Hambleton, John W. Huddle, Virginia M. Jussen, E. R. Landis, Elisabeth S. Loud, Sergius H. Mamay, Mildred C. Mead, Virginia S. Neuschel, D. W. Rankin, C. L. Sainsbury, Dwight L. Schmidt, and Dorothy B. Vitaliano.

ABSTRACTS

03336 **Abele, Gunars.** Deformation of snow under rigid plates at a constant rate of penetration: U.S. Army Corps Engineers Cold Regions Research and Eng. Lab. Research Rept. 273, 67 p., illus., tables, 1970.

Results are reported of an experimental study of deformation of snow under a load applied to a rigid plate at a constant rate of penetration. Results are to be applied in design criteria for snow roads, runways, and foundations in polar regions. It was found that density, in the range 0.3 to 0.6 g per cm^3, can be a reasonably reliable index for predicting deformation and behavior of snow under load. In general, the critical pressure (bearing strength) increases and critical sinkage decreases as a power of function of density; the deformation bulb resembles the typical Boussinesq stress bulb. Test data did not provide conclusive evidence of the effect of plate size on deformation and bearing capacity. — *from* Author's abstract

03092 **Adeyeri, Joseph Babalola.** Multiple integral description of the viscoelastic response of cohesive soils [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4604B-4605B, 1970.

03363 **Ahrens, Thomas J.; Fleischer, Robert L.; Price, P. Buford; Woods, Richard T.** Erasure of fission tracks in glasses and silicates by shock waves: Earth and Planetary Sci. Letters, v. 8, no. 6, p. 420-426, illus., tables, 1970.

Shock loading experiments have been carried out to determine the effect of dynamic pressures and associated temperatures on fission tracks in tektite and soda lime glasses, biotite, and apatite. Below 83 ± 4 and 31 ± 3 kb, track densities remain unaltered in the tektite and soda-lime glass, respectively. In tektite glass, partial and complete erasure occurs above 112 ± 2 and 133 ± 10 kb; in soda-lime glass partial erasure is observed above 33 ± 3 and 42 ± 3 kb. Shock temperature calculations show that the shock temperatures on the glasses are lower than those at which tracks would be annealed under static conditions. Single crystals of apatite retain tracks when shocked to 45 ± 5 kb. Apatite recovered from shock pressures above 82 ± 5 kb is granulated to micronized particles which preclude recognition of tracks. Biotite shows no appreciable loss in fission track density when shocked up to 173 ± 5 kb. — *from* Author's abstract

03567 **Aitken, James D.** The northern Great Plains, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 187-190, 1970.

The largest single producing asset of this region is the lead-zinc deposit at Pine Point, Northwest Territories, and the second is the Norman Wells oil field, Northwest Territories; large accumulations of hydrocarbons have the greatest economic potential. In estimating this potential the area is divided into five parts, the most promising of which is the Mackenzie Delta and coastal plain. The northern Great Plains is a great laboratory for the study of arctic and subarctic landforms, processes, and permafrost problems. Six phases of earth science research in the area are recognized, and five major advances are listed. The present level of activity for industry, government, and universities is reviewed. Seven areas in which exploration is most needed are listed, four future trends outlined, and five recommendations made to the Solid-Earth Sciences Subcommittee. — ESL

Allan, J. R. *See* Schopf, Thomas J. M. 03345

Allan, R. J. *See* Hornbrook, E. H. W. 03022

03465 **Allen, J. M.; Wynne, F. L.; Richardson, J.** Valley Copper, a case history [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 295, 1970.

03426 **Allen, James E.** New species of Eocene Mollusca from the Gulf Coast: Tulane Studies Geology and Paleontology, v. 8, no. 2, p. 69-78, 1970.

Two genera and eight species of gastropods and one bivalve species from the middle and upper Eocene of the Gulf Coast embayment [Grant and Winn Parishes, La.; Hinds County, Miss.] are described as new. The new monotypic genus *Sablea* is the first Eocene assignment within the family Lepetellidae and *Eodaphne*, a new genus in the subfamily Daphnellinae of the family Turridae, is the earliest reported occurrence of a true daphnellid decussated protoconch. [New species of *Viviparus*, *Capulus*, *Colubraria*, *Latirus* (*Polygona*), *Sinnistrella*, *Philine* (*Megostoma*), and the bivalve *Plicatula* are also described.] — Author's abstract

Alpha, Tau R. *See* Carlson, Paul R. 03078

Alpha, Tau Rho. *See* Scholl, David W. 03531

Alpha, Tau Rho. *See* Nelson, C. Hans. 03532

03103 **Al-Rawi, Yehya Tawfeq.** Cenozoic history of the northern part of Mono Basin, California and Nevada [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4660B, 1970.

Alsop, L. E. *See* Knopoff, L. 03679

03622 **Am. Soc. Civil Engineers.** (Task Comm. on Preparation of Sedimentation Manual). Sediment sources and sediment yields, Chap. 4: Am. Soc. Civil Engineers Proc., v. 96, paper 7337, Jour. Hydraulics Div., no. HY 6, p. 1283-1329, illus., tables, 1970.

Methods and procedures are analyzed for determining erosion rates from waterborne sediments, along with sediment yield or deposition rates downstream from the erosion source. Emphasis is on the erosion types and processes which cause the most engineering problems, either by virtue of the large sediment quantities involved or by locally severe damages incurred. Accelerated erosion or deposition rates from man's activities are of special concern: sheet erosion on tilled lands; strip mining, urban development, construction of highways and utilities; sheet erosion on denuded or inadequately protected land surfaces. Erosion and deposition rates caused by channelization or runoff waters in upland gullies and downstream drainageways are also considered. Present bases for estimating these rates, on both a storm and an average annual basis, are given. — *from* ASCE abstract

03685 **Am. Soc. Civil Engineers.** (Comm. on Tidal Hydraulics). Research needs on thermal and sedimentary pollution in tidal waters: Am. Soc. Civil Engineers Proc., v. 96, paper 7426, Jour. Hydraulics Div., no. HY 7, p. 1539-1548, 1970.

The ASCE Tidal Hydraulics Committee has agreed that thermal and sedimentary pollution of tidal water bodies is the major problem in this field. Over a period of a year valuable ideas and suggestions have been obtained from all committee members on identifying the nature of the problems and suggesting smaller specific investigations. In this report it is pointed out that behavior of the fine estuarine sediments, often derived from stripped construction areas, can be affected by water quality, electrolytes and temperature; they serve as vehicles by which contaminating materials are transported; and their flocculation increases strength of density currents. Included is a review of the literature and some related research, outlines of general and specific research needs in both thermal and sedimentary pollution, and a section on instrumentation. — GDC

Amein, Michael. *See* Langfelder, Leonard J. 03718

Ames, H. T. *See* Traverse, A. 03702

03242 **Ames, Roger Lyman.** Sulfur isotope study of the Tintic mining district, Utah [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5096B, 1970.

Anders, Edward. *See* Mazor, Emanuel. 03159

03027 **Andersland, Orlando B.; Douglas, Arthur G.; Ramanatha Iyer, T. S.; Mohamed, S. M. M.** Bonding, effective stresses, and strength of soils — Discussion [of paper 6786 by J. K. Mitchell, A. Singh, and R. G. Campanella, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 1073-1077, 1970.

Paper 6786 (ibid., v. 95, no. SM5, p. 1219-1246, 1969) was cited in Abstracts of North American Geology, April 1970.

Anderson, C. N. *See* Vogt, P. R. 03670

Anderson, Don. *See* Sammis, Charles. 03561

03697 **Anderson, Don L.; Anderson, Orson L.** The bulk modulus-volume relationship for oxides: Jour. Geophys. Research, v. 75, no. 17, p. 3494-3500, illus., tables, 1970.

The relationship KV_o = constant is shown to hold for oxides. The product of bulk modulus and volume depends on crystal structure, valence product, and a repulsive parameter. The exponential repulsive parameter ρ [calculated for oxides crystallizing in structures for which elastic constant data are available] satisfies the relationship $\rho = 0.05\ (1 + R + 3\Delta R)$, where R = cube root of molecular volume and ΔR = difference between R and small cation radius. The reduced Madelung constant $\alpha = A/mz_1z_2$ (A = conventional Madelung constant, z_1z_2 = valence product, and m = number of ions in the chemical formula) satisfies the relation $\alpha = 0.20 + 0.45\ \Delta R$. The calculated values of bulk modulus and repulsive parameter can be used to estimate densities at megabar pressures to within about 1 percent. — DBV

Anderson, Orson L. *See* Anderson, Don L. 03697

Anderson, Warren. *See* Snell, L. J. 03382

Andreasen, Gordon E. *See* Zietz, Isidore. 03672

Aoki, Ken-Ichiro. *See* Kuno, Hisashi. 03767

03512 **Arabasz, Walter J.; Brune, James N.; Engen, Gladys R.** Locations of small earthquakes near the trifurcation of the San Jacinto fault southeast of Anza, California: Seismol. Soc. America Bull., v. 60, no. 2, p. 617-627, illus., table, 1970.

About 100 small earthquakes, M about 2, near the trifurcation of the San Jacinto fault southeast of Anza, Calif., have been located using five- and six-station arrays. The pattern of epicenters is complex and extends several km outside the area outlined by traces of faulting. On the southwest side of San Jacinto fault, a concentration of foci lies at a depth of 4-7 km along the projected extension of Coyote Creek fault. On the northeast side, earthquakes are concentrated at depths between 10 and 15 km. A group of the latter events recorded about one week after the magnitude 4.7 earthquake of May 21, 1967 forms a linear pattern parallel to San Jacinto fault with depths from 3 to 15 km; this pattern may represent the zone of energy release or slip for that earthquake and possibly the plane of the San Jacinto fault at depth. Most earthquakes represent a complex pattern of seismicity which has continued for the last 3 years on the microearthquake level and for the last 30 years on the macroseismic level. — *from* Authors' abstract

03217 **Archbold, N. L.; Paul, Richard R.** Geology and mineral deposits of the Pamlico mining district, Mineral County, Nevada: Nevada Bur. Mines Bull. 74, 12 p., illus., geol. map, 1970.

The Pamlico mining district is in the western Garfield Hills about 10 miles southeast of Hawthorne, Mineral County, Nevada. The most abundant rock exposures consist of a complex volcanic and sedimentary sequence ranging from Permian (?) to Early Jurassic age. This sequence is intruded by younger bodies of quartz monzonite, and both are overlain by volcanic rocks of Tertiary to Quaternary age. Main structures consist of northwest-trending folds and faults cut in part by north-trending faults.

Gold was produced mainly from two types of deposits, gold-quartz veins in volcanic rocks of the Excelsior(?) Formation as illustrated in the Pamlico mines, and limonitic lodes in the Luning Formation as represented in the La Panta mines. Copper occurs along a contact zone between quartz monzonite and limestone at the Gold Bug mine. Silver may have been obtained from argentiferous galena in the Gold Range Formation. — *from* Author's abstract

03695 **Aronson, J. R.; Bellotti, L. H.; Eckroad, S. W.; Emslie, A. G.; McConnell, R. K.; von Thüna, P. C.** Infrared spectra and radiative thermal conductivity of minerals at high temperatures: Jour. Geophys. Research, v. 75, no. 17, p. 3443-3456, illus., tables, 1970.

To evaluate the magnitude of radiative thermal conductivity in planetary interiors, it is necessary to measure the high-temperature absorption coefficient and refractive index of relevant minerals in the appropriate spectral region. Results of near-infrared measurements on samples of olivine, diopside, and oligoclase at temperatures up to 1723° K show continuous broadening of vibrational and electronic bands involved, with a consequent substantial increase in mineral opacity in a spectral region that is effectively a window for room-temperature samples. This opacity significantly decreases the magnitude of radiative thermal conductivity from what one would predict from room-temperature spectra. — *from* Authors' abstract

03411 **Attaway, David; Parker, P. L.** Sterols in recent marine sediments: Science, v. 169, no. 3946, p. 674-676, illus., 1970.

Sterolic fractions have been isolated from Recent marine sediments representing two different environments. The fractions were characterized by infrared spectroscopy and thin-layer chromatography. The major sterols in the fractions were identified by gas chromatography and mass spectrometry. The demonstrated survival of these common plant and animal sterols for several thousand years suggests that these molecules will be useful geochemical indicators. — Authors' abstract

03129 **Atwood, George L.** Bulldozers peel waste to 3-inch tolerance from steep P_2O_5 beds: World Mining, v. 6, no. 5, p. 46-49, illus., 1970.

The Henry phosphate mine, about 18 miles north of Soda Springs, Idaho, is a strip mine opened in 1969. Drilling procedures, seismic traverses, and trenching utilized in exploration of the site are summarized briefly. The upper ore zone, 17 feet thick, consists of interbedded phosphorite, phosphatic shale and limy mudstones and averages 11.0 percent P. A low-grade shale ore zone, separated from the upper zone by a waste zone, consists of 14 feet of phosphatic shale with interbedded mudstone and averages 8.0 percent P. A medium grade ore lies below this and has 17 feet of phosphorite and phosphatic shale averaging 12 percent P. The high-grade ore zone, separated from the medium by two feet of dolomite, consists of six feet of phosphorite averaging 13+ percent P. Pit design, stripping tools, and other problems are discussed. — VSN

03153 **Aumento, F.** Serpentine mineralogy of ultrabasic intrusions in Canada and on the Mid-Atlantic Ridge: Canada Geol. Survey Paper 69-53, 51 p., illus., tables, 1970.

Serpentine and associated minerals from the stratiform Muskox Intrusion (N.W.T.), alpine-type Mount Albert and Jeffrey (asbestos) Mine intrusions of Quebec, and Mid-Atlantic Ridge were investigated by X-ray diffraction. Predominant in all three types, lizardites have the smallest cell parameters in the Mid-Atlantic Ridge; the largest occur in the alpine serpentinites associated with brucite, which is rare in the other two types. Cell parameters and brucite content variations indicate different temperatures of serpentinization of the intrusive bodies: hottest (near 485°C) on the Mid-Atlantic Ridge, intermediate to hot in stratiform, and coolest (400°C or less) in alpine types. Serpentinization in the latter was contemporaneous with diapiric emplacement of cool, semicrystalline ultrabasic masses; and probably occurred in stratiform and midoceanic types on cooling after emplacement and termination of differentiation by crystal settling. — *from* Author's abstract

03492 **Austin, George.** A teacher's guide for geologic field investigations in southwestern Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, 10 p., illus. [n.d.].

The area south of the Minnesota River and west of Mankato has four units at the surface, all separated by long erosional periods. The oldest is the Precambrian basement rocks, outcropping in the river valley. The second, exposed to the east, is Cambrian-Ordovician. Third, a widespread Cretaceous unit covers much of the area. The uppermost unit is Pleistocene drift which covers everything except where streams have removed it. There are two types of Precambrian rock present: a schist, by far the oldest, and the Sioux Quartzite. Subjects studied at seven stops are: structural and glacial history, sedimentation, and the Cretaceous sediments at Springfield. — ESL

03160 **Austria, V. B., Jr.** The Cu, Pb, Zn, Mn, and Mo content of stream and spring sediments, southwestern New Brunswick, N.T.S. 21-G/6, 7, 8W, 10, 11: New Brunswick Dept. Nat. Resources Mineral Resources Br. Rept. Inv. 11, 19 p., illus., geol. map, 1970.

Highly deformed metamorphic bedrocks (Ordovician-Devonian), with granitic and gabbroic intrusions in the west, are unconformably overlain in the north by Carboniferous volcanic and sedimentary rocks and erosional remnants of Pennsylvanian sandstones. Variations in distribution of five elements geochemically searched are indicated on separate maps; all have higher than normal concentrations in the south. Diagrammed results of correlation tests made on groups of samples representing environments of granitic, nongranitic, and mineralized bedrock show copper more evenly distributed, apparently not sensitive to manganese content of sediments. Particular need is to establish the significance of anomalies directly associated with known mineral occurrences. Nature of dispersion of manganese in the sediments is not known; positive relations between it and Zn, Pb, and Mo suggest that these metals probably could form anomalies in Mn-rich sediments. — GDC

Auzende, Jean-Marie. *See* Pautot, Guy. 03395

03649 **Baer, A. J.** The Grenville province, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 200-203, illus., 1970.

The exposed part of the Grenville province is the southeastern part of the shield, with K-Ar ages of about 1,000 m.y. It is bounded on the northwest by the Grenville front, a linear tectonic feature reflecting a metamorphic transition, and/or a fault. Earth science is essential to development of the metallic and industrial mineral resources. History of earth science research is divided into four parts: up to 1863, 1863-1910, 1910-1956, and 1956 to the present. The present level of activity for Federal and Provincial Governments and universities is summarized. Seven areas where activity needs to be increased are discussed, and most important objectives and future trends are listed. Eleven recommendations for research are given. — ESL

Baerreis, David A. *See* Bender, Margaret M. 03188

03468 **Baird, D. M.** Sand: Canadian Geog. Jour., v. 80, no. 6, p. 194-201, illus., 1970.

Sand forms a part of almost all soils, and is economically important. Mineral composition of sand, and shapes and sizes of grains may show its origin. Most sand comes from slow crumbling of solid rocks, and chemical breakdown of the other minerals. Processes shaping and transporting sand grains, including turbidity currents, are discussed. — ESL

03191 **Baker, C. H., Jr.** Water resources of the Heber-Kamas-Park City area, north-central Utah: Utah Dept. Nat. Resources Tech. Pub. 27, 79 p., illus., tables, geol. map, 1970.

Consolidated rocks of the Wasatch Range and Uinta Mountains contain large quantities of ground water, mostly in fractures and solution openings but also from numerous springs; however, yields are low due to low permeability of the rocks. Most

wells derive water from unconsolidated alluvial fill in the four mountain valleys where the fill may be as much as 800 feet thick; aquifer characteristics in the four valleys are generally similar. Ground water in the valley fill interchanges continuously with water in streams and none of the aquifers can be dewatered for consumptive use without ultimately reducing streamflow. Water is generally of good quality and with few exceptions, usable for domestic use, livestock, and irrigation. — *from* Author's abstract

03374 **Balkwill, H. R.; Yorath, C. J.** Simpson Lake map-area, District of Mackenzie (97B): Canada Geol. Survey Paper 69-10, 10 p., illus., table, geol. map, 1970.

Rocks exposed in the Simpson Lake map-area belong to the Cambrian, Ordovician, Devonian, and Cretaceous Systems. About 2,000 feet of Paleozoic rocks, chiefly carbonates with subordinate shales, are mapped from oldest to youngest as: "Ronning Group," and Bear Rock, Hume, and Hare Indian Formations. Paleozoic strata are regionally overlapped by widespread, but poorly exposed, Cretaceous clastic rocks. Informal Cretaceous units, which have an estimated total thickness of about 1,500 feet, are the "Silty," "Bentonitic," and "Bituminous zones" (from oldest to youngest). Rocks in the map-area dip regionally westward to northwestward at small angles. There appear to be few structural complications, although small structures may be concealed by Pleistocene drift. — Authors' abstract

Bannister, R. G. *See* Rushton, K. R. 03572

Bararova, T. Y. *See* Sobolev, V. S. 03577

03627 **Barden, Laing; Sides, Geoffrey R.** Engineering behavior and structure of compacted clay: Am. Soc. Civil Engineers Proc., v. 96, paper 7397, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1171-1200, illus., table, 1970.

The engineering properties of a compacted partly saturated clay have been determined in a comprehensive series of laboratory investigations. The results have been correlated with the previously published results of a large number of workers on other clays. Molding water content has been shown to have a dominant effect on a wide range of engineering properties of a compacted clay soil. Microscopic examination of the soil structure has revealed that the major differences exist in the macrostructure, and these have been shown to account for the main variations in engineering behavior. The practical implications of the findings are summarized. — ASCE abstract

03195 **Bare, Janét E.; McGregor, Ronald L.** An introduction to the phytogeography of Kansas: Kansas Univ. Sci. Bull., v. 48, no. 26, p. 869-949, illus., tables, 1970.

Vascular flora of Kansas is composed of species not confined to the Great Plains; most are believed to have migrated into the area during Tertiary or later times, though it is probable that some evolved within the Plains. Paleobotanical evidence, recorded accounts of native flora at time of white man's arrival, and present distribution patterns suggest the flora of Kansas is related to eight major centers of frequency — the east, northeast, southeast, south, southwest, north, interior, and Great Plains — and also contains a number of widespread species. Major patterns of distribution exhibited by species entering the state are described and tentative conclusions regarding ecological factors which seem most influential in determining these patterns are discussed. More work on biosystematics of plains species will yield information of real value in interpreting phytogeographic problems. — *from* Authors' abstract

03243 **Barlow, James Arthur.** Stratigraphy and paleobotany of the youngest Pennsylvanian strata in the Caryville, Tennessee area [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5096B, 1970.

03459 **Barringer, R. R.; McNeill, J. D.** The airborne RADIOPHASE^{TM} system, a review of experience [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 291, 1970.

03244 **Barrows, Allan Geer, Jr.** Geology of the Hamburg-McGuffy Creek area, Siskiyou County, California, and petrology of the Tom Martin ultramafic complex [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5096B-5097B, 1970.

Bauer, A. *See* Calder, Peter N. 03457

Bazarov, L. Sh. *See* Sobolev, V. S. 03577

03301 **Beaudet, Paul R.** Elastic wave propagation in heterogeneous media: Seismol. Soc. America Bull., v. 60, no. 3, p. 769-784, illus., 1970.

The wave equation is solved for the ensemble average of particle displacements produced by an explosion. The explosion is assumed to occur in a finite cavity in an infinite heterogeneous medium. The solution is applied to the seismic waves generated by an underground nuclear detonation. Field observations from the underground nuclear test program at the Nevada Test Site are in qualitative agreement with the theory. — Author's abstract

03408 **Beaumont, C.; Hyndman, R. D.; Keen, M. J.** A new technique for the installation of tiltmeters: Earth and Planetary Sci. Letters, v. 8, no. 5, p. 337-340, illus., 1970.

Two Verbaandert-Melchior tiltmeters have been installed in a metal pipe vault which is buried at a depth of 5 meters and resting on bedrock. The apparatus is designed to measure the earth tide and tidal loading in the vicinity of Halifax, Nova Scotia. — Authors' abstract

03529 **Beck, L. S.** Genesis of uranium in the Athabasca region and its significance in exploration: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 367-377, illus., table, 1970.

The Athabasca region forms part of the Churchill province of the Canadian Shield and is underlain by an Archean or Aphebian assemblage of rocks that underwent severe metamorphism and granitization during the Hudsonian orogeny. In places, the eroded orogen is overlain by unmetamorphosed cover rocks of probable Paleohelikian age. Basic dikes cut all rocks of the region. There are innumerable vein-type pitchblende deposits and many syngenetic occurrences of uraninite in crystalline basement rocks. Pitchblende was emplaced during final stages of Hudsonian granitization and followed crystallization of syngenetic uraninite transitionally. In terms of P-T conditions, pitchblende deposits belong to Lindgren's mesothermal group. Based on postulated uranium metallogenesis, possibilities of finding further deposits of pitchblende and other types of uranium deposits are discussed. — *from* Author's abstract

03245 **Beck, Myrl Emil, Jr.** Paleomagnetism and magnetic intensities of Keweenawan intrusive rocks from northeastern Minnesota [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5106B, 1970.

03146 **Beebe, B. W.** Natural gas, oil's principal competitor [abs.]: Corpus Christi Geol. Soc. Bull., v. 10, no. 8, p. 4-5, 1970; South Texas Geol. Soc. Bull., v. 10, no. 7, p. 2-3, 1970.

Begg, E. L. *See* Hansen, R. O. 03406

03327 **Belcher, Donald J.** Successful computerization for resources mapping: Jour. Remote Sensing, v. 1, no. 1, p. 7-10, illus. p. 4-5, 1970.

A *Planmap* system has been developed at Cornell University mainly for land use and natural resource inventories. The computer programs are available for calling for tabulated summaries and for maps of the inventory area in graphic display form. The user can decide on, and call for, maps that will display virtually any combination of stored data in the fields of soils, land use, topography, ground water, and geomorphology. An additional application is in potentially hazardous areas, to show where a hazard exists, or to forecast occurrence of such events as flooding, landslides, mudflows, subsidence and collapse, tsunamis, and earthquakes. — MCM

Bellotti, L. H. *See* Aronson, J. R. 03695

03188 **Bender, Margaret M.; Bryson, Reid A.; Baerreis, David A.** University of Wisconsin radiocarbon dates VIII: Radiocarbon, v. 12, no. 2, p. 640-643, 1970.

03069 **Ben-Menahem, Ari; Gillon, Allon.** Crustal deformation by earthquakes and explosions: Seismol. Soc. America Bull., v. 60, no. 1, p. 193-215, illus., tables, 1970.

Static displacements were calculated for an earth model having a single layer of thickness H overlying a homogeneous half space. Localized sources simulating earthquake and explosion focuses are placed at depths $h = H/2$ and $h = 3H/2$. The ensuing surface deformation is evaluated as a function of epicentral distance for a typical continental crust model. A new technique is used for the quadrature of the displacement integrals, by means of which 1,000 layer-integrals of a certain type (the expression for which is given) can be calculated. It is found that for epicentral distances $r > 20H$ the displacements decay as $(r/H)^{-alpha}$. For compressional and strike-slip source above the layer, $\alpha = 2$ to 3; for a dip-slip source below the layer, $\alpha = 3$ to 5. Maximum for vertical and radial displacement, displacement parallel and perpendicular to the fault, and displacement on the free surface occur approximately at $r = 0.8h$ and decay with source depth as $h^{-1.5}$. — DBV

03140 **Bennett, G. A.; Manuel, O. K.** Xenon in natural gases: Geochim. et Cosmochim. Acta, v. 34, no. 5, p. 593-610, illus., tables, 1970.

Analysis of noble gases from four natural gases reveal radiogenic He-4 and Ar-40, excess Ne-21 and Ar-38 from α-induced reactions and an excess of the β-unshielded xenon isotopes with an abundance pattern unlike that from the spontaneous fission of U-238. A mixture of this xenon with primordial xenon in meteorites could produce the abundance pattern of atmospheric xenon for all isotopes heavier than Xe-128. It is suggested that the addition of β-shielded xenon isotopes to the atmosphere by the solar wind can account for the general isotopic anomaly pattern observed across meteoritic xenon, the very low fission yields of Xe-131 and Xe-132 reported in xenon-rich meteorites and the high fission yields of Xe-131 and Xe-132 which have been calculated for xenon in gas wells and in the Earth's atomsphere. — *from* Authors' abstract

Bennett, Theron J. *See* Gordon, David W. 03309

Benton, L. F. *See* Cardwell, L. E. 03165

03343 **Berger, Wolfgang H.; Parker, Frances L.** Diversity of planktonic foraminifera in deep-sea sediments: Science, v. 168, no. 3937, p. 1345-1347, illus., 1970.

The diversity of a planktonic foraminiferal assemblage on the ocean floor depends on the state of preservation of that assemblage. As dissolution progresses, species diversity (number of species in the assemblage) decreases, but compound diversity (based on relative species abundance) first increases and then decreases; species dominance first decreases and then increases. The reason for these changes is that the species most susceptible to solution deliver more sediment to the ocean floor than do species with solution-resistant shells, possibly because the more soluble tests are produced in surface waters, where growth and production are greatest. — Authors' abstract

Bernard, Claude. *See* Laverdiere, Camille. 03128

03641 **Bertine, K. K.; Chan, L. H.; Turekian, K. K.** Uranium determinations in deep-sea sediments and natural waters using fission tracks: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 641-648, illus., tables, 1970.

Uranium determinations by induced fission track analysis were done rapidly utilizing a discharge counter instead of visual counting. Sediments, rocks, freeze-dried river salts (with Na_2CO_3 carrier) and one freeze-dried sea salt were analyzed by this technique. Comparisons with samples whose uranium concentrations were determined independently indicate that the method is accurate. The uranium concentration in deep-sea sediments varies widely with oceanic depth and depth in the core

ranging from 0.5-40 ppm U on a calcium carbonate-free basis. Seventeen river water samples range between < 0.01 and 1.2 μg U/l with an average value of 0.27 μg U/l. — Authors' abstract

03699 **Bicker, Alvin R., Jr.** Economic minerals of Mississippi: Mississippi Geol., Econ. and Topog. Survey Bull. 112, 80 p., illus., tables, 1970.

Mineral commodities discussed in this report include those which have some economic value and minor minerals even though commercial production is nonexistent; those of more economic significance are treated in greater detail. Geologic and geographic distribution are given with some sketch maps. In 1969 petroleum and allied products represented 87.6 percent of the total value of mineral production, but nonmetallic minerals are showing tremendous growth. The prospect of increased mineral production is excellent, not only in petroleum, but also in construction materials and industrial minerals. — *from* Author's abstract

03441 **Bieberman, Robert A.** (compiler). Index to samples from oil and gas well tests in library at Socorro, New Mexico, July 1, 1966 to June 1, 1970: New Mexico Bur. Mines and Mineral Resources Circ. 109, 10 p., tables, 1970.

Samples from over 8,400 wells from all parts of New Mexico are included in this collection which is indexed and readily available for study by qualified individuals and organizations. Wells are listed by section, township, and range. Although only a small proportion of the field wells are represented, every effort have has been made to secure samples from wildcat tests. Circulars in this series of indexes have been published since 1955. — MCM

Birch, Francis. *See* Mao, Nai-Hsien. 03730

03246 **Birch, Francis Sylvanus.** Geological and geophysical studies of the Barracuda fault zone in western North Atlantic Ocean [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5107B, 1970.

Bjorklund, L. J. *See* Sumsion, C. T. 03063

03646 **Black, Craig C.** A new *Pareumys* (Rodentia: Cylindrodontidae) from the Duchesne River Formation, Utah: Fieldiana — Geology, v. 16, no. 17, p. 453-459, illus., 1970.

A number of mammalian specimens were collected from the Eocene La Point Member at the top of the Duchesne River Formation, including the two jaws described and illustrated here as a new species of *Pareumys*. The fauna from this member shows little resemblance to those from the Randlett Member at the base of the same formation, or from the Chadron Formation. Relationships of the genus *Pareumys* are discussed. It appears that *P. guensburgi* is the last representative of the genus. — ESL

Blake, W., Jr. *See* Lowdon, J. A. 03183

03358 **Blume, John A.** An engineering intensity scale for earthquakes and other ground motion: Seismol. Soc. America Bull., v. 60, no. 1, p. 217-229, illus., tables, 1970.

An engineering intensity scale is proposed for earthquakes and for ground motion resulting from nuclear or chemical explosions. It is based upon 5 percent damped response spectra developed from the ground motion and a standard 10 × 9 matrix with columns representing period bands and rows representing prescribed response velocity levels, S_v. Acceleration or relative displacement can also be readily assigned with the use of 4-way logarithmic paper. The EI scale can be reported by period column as 9-digit, 3-digit, or 1-digit numbers, or by all three in a standard format. The more digits reported, the greater the amount of information on the period bands. — *from* Author's abstract

Blundell, D. J. *See* Shotton, F. W. 03182

03230 **Bodily, Norman M.** An armored dinosaur from the Lower Cretaceous of Utah: Brigham Young Univ. Geology Studies, v. 16, pt. 3, p. 35-60, illus., tables, 1969 [1970].

An armored dinosaur from the Lower Cretaceous Cedar Mountain Formation of eastern Utah is described. The collection, consisting of vertebrae and dermal armor plates, amounts to thirty percent of one animal. The fossil described in this paper bears close similarity to *Hoplitosaurus marshi* (Lucas, 1901) and is tentatively placed in the genus *Hoplitosaurus*. A close similarity to *Polacanthus foxi* (Hulke, 1882) is also evident, and references are made to it in description of the present material, particularly to the positioning of the dermal armor. The recent discovery of another armored dinosaur five miles southeast of the present fossil locality indicates favorable environmental conditions for armored dinosaurs during deposition of the Cedar Mountain Formation. — *from* Author's abstract

03766 **Boettcher, A. L.** Hydrothermal melting relationships in silicate-H_2O systems at vapor pressures greater than 10 kbars [abs.], *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 331, 1970.

03192 **Bogorov, G. V.** Morphometric features of the northern part of the Mid-Atlantic Ridge: Oceanology, v. 9, no. 6, p. 833-842, illus., 1969 [1970]; originally published in Russian, 1969.

The Russian version (Okeanologiya, v. 9, no. 6, p. 1038-1048, 1969) was cited in Abstracts of North American Geology, October 1970.

Bolke, E. L. *See* Sumsion, C. T. 03063

03681 **Bollinger, G. A.** Travel-time study of six central Appalachian earthquakes: Seismol. Soc. America Bull., v. 60, no. 2, p. 629-637, illus., tables, 1970.

Traveltime studies are made of data from six central Appalachian earthquakes that occurred during the period 1962 through 1968 in the states of Virginia, West Virginia, Maryland, and North Carolina. Arrival times from 42 station-epicenter pairs served as input data for the study. Epicentral locations were obtained for the six events with an average standard deviation for the traveltime residuals of 0.5 sec. Nineteen Pn observations in the distance range of 300 to 800 km yield a composite Pn traveltime curve given by $t = (8.98 \pm 0.14)$ sec $+ <\!/(8.22 \pm 0.02)$ km per sec with a 0.19 sec standard deviation in the traveltime observations. The inverse slope for the Pg phase was found at 6.24 ± 0.03 km per sec and for the Sg or Lg phases at 3.67 ± 0.02 km per sec. Magnitude determinations using m_{eve} of Evernden (1967) are made for two of the five shocks. — Author's abstract

03041 **Bolt, Bruce A.** Causes of earthquakes, Chap. 2 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 21-45, illus., 1970.

This paper discusses possible mechanisms for earthquakes in which energy release is near the surface and large enough to damage structures. The following are examined and illustrated by examples from California: global distribution and fine structure of occurrence of earthquakes; methods of estimating energy release and the strain field; modes of fault slippage; dilatational and elastic rebound theories of earthquake generation; and a plausible dynamic model for mechanism parameters. Quantitative predictions of dynamics of ground motion may be based on measurements of deformation for a particular earthquake together with a theory of earthquake genesis. The elastic rebound theory in which faulting is considered to be the cause of shallow focus earthquakes, not the consequence of them, is considered to be the more reasonable theory. — VSN

03444 **Bolt, Bruce A.** Elastic waves in the vicinity of the earthquake source, Chap. 1 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 1-20, illus., 1970.

The behavior of both standing and traveling seismic waves in a layered conformable medium near to an earthquake source is considered. Elastic waves predicted by the infinitesimal strain theory of perfectly elastic, Hookian, isotropic medium with homogeneous layers can account for the principal part of observed motion on rock or firm ground following earthquakes. Anomalous behavior can be explained if deviations are allowed; particularly important are structure and elastic heterogeneity, viscosity, nonlinear elastic behavior, and anisotropy of soil and rock. Distortion of wave fronts, scattering, diffraction, and mode conversion occur at structural interfaces, and wave motion bears the key signature imparted by the nature and extent of the source; much of the complication of ground vibrations are from these phenomena. — *from* Author's summary

03662 **Bolyard, Dudley W.** Muddy Sand oil potential in South Dakota [summ.]: Houston Geol. Soc. Bull., v. 12, no. 7, p. 18, 1970.

Bonatti, Enrico. *See* Gomberg, David N. 03758

03042 **Bonilla, M. G.** Surface faulting and related effects, Chap. 3 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 47-74, illus., table, 1970.

Faults and faulting are of importance to engineers because they can severely damage or destroy structures by shearing, compression, extension and rotation caused by tilting or bending; also earthquakes may occur along them. This chapter reviews faulting as observed in continental United States and adjacent parts of Mexico, including: surface mainfestations, sudden rupture and displacement, length of surface rupture, fault displacements, map pattern of faults, subsidiary faults, width of faulting zones, absorption of rupture in rock and soil, extension and compression, surface deformation, geographic distribution of historic faulting; faulting and earthquakes; and future faulting. A detailed tabulation is included of historic surface faulting. — VSN

03026 **Borchardt, Glenn Arnold.** Neutron activation analysis for correlating volcanic ash soils [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 4870B-4871B, 1970.

03352 **Borcherdt, R. D.** Effects of local geology on ground motion near San Francisco Bay: Seismol. Soc. America Bull., v. 60, no. 1, p. 29-61, illus., tables, 1970.

Measurements of ground motion generated by nuclear explosions in Nevada were made for 37 locations near San Francisco Bay, Calif. For recording sites underlain by younger bay mud or artificial fill, maximum horizontal ground velocities generally increased with layer thickness and were as much as ten times greater than those on nearby bedrock. Maximum vertical amplification curves clearly define a "dominant ground period" of about 1 sec for sites underlain by younger bay mud, and older, more consolidated sediments, no clearly defined "dominant ground period" was found. Maximum ground velocities for older bay sediments were about twice those on bedrock. Consistent correlations of results from nuclear recordings with the 1906 earthquake intensities and spectral amplification curves for the San Francisco earthquake of March 22, 1957, suggest that areas of high amplification determined from small ground motions may be areas of high intensity in future earthquakes. — DBV

03478 **Boyle, R. W.; Wanless, R. K.; Stevens, R. D.** Sulfur isotope investigation of the lead-zinc-silver-cadmium deposits of the Keno Hill-Galena Hill area, Yukon, Canada: Econ. Geology, v. 65, no. 1, p. 1-10, illus., tables, 1970.

Sulfur in the sulfides of the sedimentary rocks of the Keno Hill-Galena Hill area, Yukon, Canada is relatively enriched in S^{34} compared with sulfides in the lead-zinc-silver-cadmium lodes. These data support the thesis that during diffusion of the sulfur from the country rocks the lighter S^{32} isotope was selectively concentrated in the sulfide deposits. The sulfur isotope ratio of supergene sulfates in the oxidized zones of the deposits reflects the ratio in the hypogene sulfides. Similarly, the ratio in the sulfate of the waters leaching mineralized zones reflects the ratio in the ores, a fact that may be useful in hydrogeochemical prospecting in the area. — Authors' abstract

03344 **Brace, W. F.; Byerlee, J. D.** California earthquakes—Why only shallow focus?: Science, v. 168, no. 3939, p. 1573-1575, illus., 1970.

Frictional sliding on sawcuts and faults in laboratory samples of granite and gabbro is markedly temperature-dependent. At pressures from 1 to 5 kilobars, stick-slip gave way to stable sliding as temperature was increased from 200° to 500° Celsius. Increased temperature with depth could thus cause the abrupt disappearance of earthquakes noted at shallow depths in California. — Authors' abstract

Bracey, D. R. *See* Vogt, P. R. 03670

Brady, Michael J. *See* Wilson, James Lee. 03607

03071 **Branson, F. A.; Owen, J. B.** Plant cover, runoff, and sediment yield relationships on Mancos shale in western Colorado: Water Resources Research, v. 6, no. 3, p. 783-790, illus., table, 1970.

Six years of vegetation measurements, four vegetation measurements methods, and 15 years of hydrologic records were used in correlation analyses near Grand Junction. Highly significant correlation coefficients were found for percent bare soil and runoff, but relationships between bare soil and sediment yield were not significant. Geomorphic parameters were more highly correlated with sediment yields than with runoff. First contact and step point vegetation measurement methods were superior to the loop and all contacts point methods. Curves for the relationship of runoff to bare soil were strikingly different for three sets of watersheds. Bare soil measurements may provide rapid and inexpensive estimates of runoff for watersheds similar to the ones studied. — *from* Authors' abstract

03731 **Braunstein, Jules.** (editor). Bibliography of Gulf Coast geology (based on compilations by Walter E. Hallgarth and others), V. 1-2: Gulf Coast Assoc. Geol. Socs. Spec. Pub. 1, v. 1, p. 1-681, illus.; v. 2, p. 683-1045, 1970.

In general, references are complete through 1968. The geographic area considered includes all of the states of Florida, Mississippi, and Louisiana, and portions of Georgia, Alabama, Tennessee, Kentucky, Illinois, Missouri, Oklahoma, Arkansas, and Texas in the United States, and Nuevo León, Coahuila, Tamaulipas, San Luis Potosí, Vera Cruz, Tabasco, Campeche, Yucatán, Quintana Roo, and Chiapas in Mexico; a sketch map indicates the areal boundary. Volume 1 contains the bibliography and volume 2 the index. – MCM

03075 **Bredehoeft, J. D.; Pinder, G. F.** Digital analysis of areal flow in multiaquifer groundwater systems, a quasi three-dimensional model: Water Resources Research, v. 6, no. 3, p. 883-888, illus., 1970.

A general solution for the response of multiple aquifer systems to pumping stress requires solving the three-dimensional flow equations. The large number of arithmetic calculations and the excessive computer storage required for a numerical solution usually precludes solving the equations in three dimensions for typical hydrologic problems. When the hydrologic system is represented by aquifers in which flow is assumed horizontal, and confining layers in which flow is assumed vertical, the problem can be reduced to solving two-dimensional equations for each aquifer, the aquifers being coupled through leakage. An iterative scheme is used to solve simultaneously the finite difference equations describing the response of confined and unconfined aquifers with or without storage in the confining layer. — Authors' abstract

Breed, William J. *See* Ford, Trevor D. 03372

03062 **Briggs, Darinka Zigic; Briggs, Louis I.** Design of information systems in a laboratory of subsurface geology: Michigan Academician, v. 2, no. 4, p. 73-86, illus., tables, 1970.

There are 50,000 items of geologic material digitized for easy access in the information system of the Subsurface Laboratory at the University of Michigan. The infor-

mation resources which include geologic material and printed documents used for teaching, research, and service functions, are organized into files of cores, core cuttings, mounted cuttings, electric logs, descriptive logs, maps, and documents. The types of information files are: catalog of materials in the laboratory, reference documents, Michigan well history, stratigraphic analysis data, sedimentary environment analysis data, and maps. The design of the system, its operation, retrieval capabilities, and evaluation of objectives are explained. — MCM

03341 **Briggs, John C.** A faunal history of the North Atlantic Ocean: Systematic Zoology, v. 19, no. 1, p. 19-34, illus., 1970.

Modern boreal faunas of the northern oceans apparently had a dual origin in Paleocene-Eocene: one cold-temperate evolutionary center in the Arctic Basin, another south of the Bering Land Bridge. In Oligocene, boreal species moved from the Arctic Basin into the North Atlantic, and southward from Bering Sea. In late Miocene and in late Pliocene, a seaway through the Bering Strait allowed Pacific species to move to the Atlantic, resulting in great change in the North Atlantic fauna. In the present North Atlantic, the depauperate shore fauna, species with broad latitudinal ranges, and complete lack of an endemic boreal pelagic group, with evidence of extensive Pleistocene faunal changes, reveal a rigorous environment in contrast to the stable Pacific environment; the primary cause clearly is variation in surface temperature. Pleistocene glacial temperatures averaged about 3°C below present winter minimum. — VMJ

Briggs, Louis I. *See* Briggs, Darinka Zigic. 03062

03145 **Brooner, Frank I., Jr.** Shale diapirs of the Lower Texas Gulf Coast as typified by the North LaWard diapir: Corpus Christi Geol. Soc. Bull., v. 10, no. 6, p. 6-10, 14-24, illus., 1970.

Most subsurface mappers of the Oligocene-Frio trend of the Gulf Coast have encountered shale or salt diapirs; much has been written about salt diapirs, but little on pure shale diapirs. The North LaWard diapir was chosen as an example of the significance of these features; it has a large number of wells drilled into the shale stock. It intruded to about 1100 feet above the base of the Frio formation, apparently as late as Upper Frio time; most Lower Frio reservoirs have been truncated and displaced by the shale. Shale diapirs that have not intruded the Lower Frio are believed to have formed many of its buried structures such as Una West, Portilla, and Copano Fields. The time and extent of intrusion by the diapiric shale seems to be a critical factor in determining the economic success or failure of these structures. — *from* Author's abstract

03464 **Brown, A. Sutherland; Cathro, R.; Panteleyev, A.; Ney, C. S.** Metallogeny of the Canadian Cordillera [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 293, 295, 1970.

03483 **Brown, Alexander C.** Environments of generation of some base-metal ore deposits — Discussion [of paper by D. E. White, 1968]: Econ. Geology, v. 65, no. 1, p. 60-61, illus., 1970.

For the original paper, *see* ibid., v. 63, no. 4, p. 301-335, 1968; Abs. North American Geology, March 1969.

Brown, Frederick S. *See* Kvenvolden, Keith A. 03164

Brune, James N. *See* Trifunac, Mihailo D. 03356

Brune, James N. *See* Arabasz, Walter J. 03512

03234 **Brunel, Pierre.** Bibliographie choisie sur l'océanographie de l'estuaire du Saint-Laurent [Selected bibliography on the oceanography of the Saint Lawrence estuary (with English and Russian abs.)]: Rev. Geographie Montréal, v. 24, no. 3, p. 277-282, 1970.

This bibliography on the oceanography of the Saint Lawrence estuary, from Trois-Rivières to long. 67° W., covers geological, geochemical, physical and chemical aspects of oceanography, as well as biological aspects. References on marine geology are confined to the actual sediments and do not cover geologic history or stratigraphy. — EH

Brutsaert, Wilfried. *See* Verma, Rameshwar D. 03684

Bryan, G. M. *See* Markl, R. G. 03637

03562 **Bryan, George M.** Hydrodynamic model of the Blake outer ridge: Jour. Geophys. Research, v. 75, no. 24, p. 4530-4537, illus., 1970.

Formation of Blake outer ridge by differential deposition of sediment on a relatively flat-lying floor (horizon A) is discussed on the basis of the hydrodynamic interaction of two oppositely directed currents, decelerated in the interaction zone and diverted to a final direction taken to be the trend of the Blake outer ridge. If one or both currents carry sediment, deposition occurs preferentially in the region of decelerated flow, so that sediment distribution is governed by the steady-state velocity field. Streamlines and isotachs computed from a model of two-dimensional streamline flow are consistent with known sediment distribution; they require upstream currents widths in substantial agreement with widths of the Florida Current and Western Boundary Undercurrent. Results suggest that the Florida Current contributes relatively coarse sediments, and the undercurrent, very fine. — *from* Author's abstract

03205 **Bryant, Bruce.** Geologic map of the Hayden Peak quadrangle, Pitkin and Gunnison Counties, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-863, scale 1:24,000, sections, 1970.

Bryson, Reid A. *See* Bender, Margaret M. 03188

Buchanan, R. M. *See* Wayman, R. A. 03742

Bucker, H. P. *See* Hamilton, E. L. 03725

Buckley, D. E. *See* Walker, D. A. 03746

03247 **Buddemeier, Robert Worth.** A radiocarbon study of the varved marine sediments of Saanich Inlet, British Columbia [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5107B, 1970.

03057 **Buell, Murray F.** Time of origin of New Jersey Pine Barrens bogs: Torrey Bot. Club Bull., v. 97, no. 2, p. 105-108, illus., 1970.

The radiocarbon dates of bottom samples from McDonalds Branch bog and a bog in a meander scar of the Oswego River are given. The former was determined as 9125 ± 195 B.P. and the latter as 10,485 ± 240 B.P. The impact of these dates on the interpretation of the published pollen diagrams for the area is discussed. — Author's abstract

Buffington, Edwin C. *See* Scholl, David W. 03531

03289 **Burke, J. J.** Observations on the Pennsylvanian crinoid *Endelocrinus armatura* (Strimple): Kirtlandia, no. 11, 10 p., illus., 1970.

Originally described as a species of *Delocrinus* by Strimple (1949), this Middle Pennsylvanian erisocrinid shows late attainment of biserial arm structure and has pits at the corners of the dorsal cup plates, both characteristic features of *Endelocrinus*. Unique ornamentation, predominantly nodose at maturity, is traceable from pit-node structure in juveniles. Discovery of new specimens from the Putnam Hill Limestone, east-central Ohio, and the No. 6 coal, Carbondale Formation, southwestern Illinois, extends the geographic range of the species from Oklahoma. — *from* Author's abstract

Burrell, D. C. *See* O'Brien, Neal R. 03599

Busch, Carl R. *See* Dirks, Richard A. 03654

03701 **Busch, F. E.; Hudson, J. D.** Ground-water levels in New Mexico, 1968: Santa Fe, N.Mex., New Mexico State Engineer, 77 p., illus., tables, 1970.

Water levels are measured annually in about 1,500 observation wells located mostly in areas where ground water is used for irrigation; measurements are made during the first quarter of each year when recovery of levels in aquifers from pumping effects of the previous irrigation season is at a maximum. Levels were generally lower in winter 1969 than in winter 1968 in most irrigated areas. The large rise in some parts of the Roswell and San Simon Creek areas may be due to better control of water use; above-normal precipitation may also have been a contributing factor in rise in water table. Change of ground-water levels in various areas is shown on 31 maps and actual measurements in 37 tables. — *from* Authors' abstract

03338 **Butler, B. Robert.** A report on the 1967-69 archaeological survey of the National Reactor Testing Station, Idaho: Tebiwa, v. 13, no. 1, p. 58-68, tables, 1970.

Artifacts collected in Pioneer Basin of the eastern Snake River Plain, Idaho, are described and listed by type. Three classes were collected: chipped stone points (chert, obsidian, ignimbrite, etc.), other flake tools, and other items such as schistose scrapers, milling stones, abraders, hammerstones, and pottery. Flake tools, especially projectile points were the most common. — VSN

03339 **Butler, B. Robert.** A surface collection from Coyote Flat, southeastern Oregon: Tebiwa, v. 13, no. 1, p. 34-57, illus., 1970.

A collection of artifacts consisting entirely of flake tools and blanks or preforms, obtained on the surface of Coyote Flat, southeastern Oregon, is described, and many specimens are illustrated. Nearly all of the 834 specimens are of obsidian with some chalcedony, jasper, chert, and opalized wood. The most outstanding feature of the collection is the concave or indented base characteristic of earliest point forms, and most of the later point forms and of all stemmed end-scrapers. — VSN

Butler, R. G. *See* Sumsion, C. T. 03063

Byerlee, J. D. *See* Brace, W. F. 03344

Byrne, J. V. *See* Nelson, C. Hans. 03532

Cabri, L. J. *See* Petruk, W. 03494

Cabri, L. J. *See* Harris, D. C. 03497

03500 **Cabri, L. J.; Harris, D. C.; Stewart, J. M.** Paracostibite (CoSbS) and nisbite ($NiSb_2$), new minerals from the Red Lake area, Ontario, Canada: Canadian Mineralogist, v. 10, pt. 2, p. 232-246, illus., tables, 1970.

Paracostibite (CoSbS) and nisbite ($NiSb_2$) are new minerals found in drill-core from the Red Lake area, Ontario. Paracostibite is orthorhombic with $a = 5.764$, $b = 5.952$, $c = 11.635$ A; $Z = 8$, space group *Pbca*, calc. D = 7.1 g/cc. It is weakly bireflecting and weakly anisotropic, showing faint polarization colors from pinkish to pale buff in oil. In air and in oil it is white in color with faint greyish tinge. Its microhardness is 1009 kg/mm² for a 15 g weight. Nisbite is also orthorhombic with $a = 5.16$, $b = 6.30$, $c = 3.84$ A; $Z = 2$, probable space group *Pnnm*, calc. D=8.0*g/cc*. In reflected light nisbite is very weakly bireflecting and appears white in oil and in air. It is also weakly anisotropic. Microhardness value is 479 kg/mm² for a 5g weight. — *frcm* Authors' abstract

03024 **Cailleux, André.** Dénomination descriptive et génétique des festes de cryoturbation [Descriptive and genetic designation of ice wedges (with English and Russian *abs.*)]: Rev. Géographie Montréal, v. 24, no. 3, p. 310-313, 1970.

The author recommends a vocabulary to describe ice wedges of various sizes and origins. — EH

Cain, Joseph C. *See* Zietz, Isidore. 03672

03457 **Calder, Peter N.; Bauer, A.; MacDougall, A. R.** Stereo-photography in open-pit mine design [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 285, 1970.

03314 **Campbell, Ian A.** Micro-relief measurements on unvegetated shale slopes: Prof. Geographer, v. 22, no. 4, p. 215-220, illus., table, 1970.

Features in shale badlands form a rewarding field of study because major changes occur over short time spans. One problem with small-scale field studies is obtaining accurate microrelief data. Microerosional and depositional studies require initial relief diagrams before on-site studies. A device based on the "bedstead" used in periglacial freeze-thaw cycle studies was used on nine sites in the badlands on Red Deer River, southern Alberta. Siting and measurement are described. The data form the basis for slope mass balance studies. Maps showing site contours on 18 July 1969 and 2 November 1969 for the nine areas, and maps with difference contours showing areas of deposition and erosion between those dates are included. — ESL

03155 **Campbell, John A.** Petrology of Devonian shelf carbonates of west central Colorado: Mtn. Geologist, v. 7, no. 2, p. 89-97, illus., table, 1970.

The Dyer Formation is composed of two distinct lithologies; the lower, predominantly limestone, is the Broken Rib Member, and the upper, predominantly dolomite, is the Coffee Pot Member. Burrows filled with micrite and small broken fossils are the most prominent structures in the Broken Rib. A shallow, warm, marine environment is indicated. Dolomites of the Coffee Pot Member are micrites, dismicrites, and intramicrites. Sedimentary structures include burrows, intraformational breccias, and roughly parallel laminations thought to have formed by trapping action of blue-green algae; breccias may have formed by disruption of dessication polygons. This member formed in an intertidal mud-flat environment. The sea transgressed from west to east during deposition of the lower Broken Rib, then regressed from east to west with deposition of the remainder of the formation. — *from* Author's abstract

03277 **Campbell, R. B.** Structural and metamorphic transitions from infrastructure to suprastructure, Cariboo Mountains, British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 67-72, illus., 1970.

Structural and metamorphic transitions in the northern Cariboo Mts. are an example of progressive change from infrastructure to suprastructure. In the Premier anticlinorium the infrastructure features the staurolite-kyanite metamorphism grade and polyphase folding whereby isoclinal folds are themselves arched across an antiformal axis. Isoclines are interpreted as flow folds in which compositional layering and schistosity are parallel. This zone passes upward through a transitional, simple anticline, where metamorphic foliation parallels bedding, into a zone of large similar or composite folds with prominent axial-plane foliation. Axial surfaces of similar folds are arranged in a fan and are about normal to surfaces of the structurally lower isoclines. The suprastructure is a zone of brittle fracture in which unmetamorphosed rocks are broken into fault blocks, tilted and locally concentrically folded. — *from* Author's abstract

03050 **Canada Geological Survey.** Abstracts of publications in scientific journals by officers of the Geological Survey of Canada, April 1969 to March 1970: Canada Geol. Survey Paper 70-4, 42 p., 1970.

This report contains abstracts of 76 papers by officers of the Geological Survey of Canada, published in scientific journals and books (other than publications of the Survey) for the designated period; abstracts are arranged alphabetically by author. There is no index. — MCM

03054 **Canada Geological Survey.** Geological Survey of Canada field activities, 1970: Canada Geol. Survey [Prelim. Ser.] Map 1-1970, scale about 1 in. to 222 mi., 1970.

Capelle, J. F. *See* Tavenas, F. 03756

03165 **Cardwell, L. E.; Benton, L. F.** Analyses of natural gases, 1969: U.S. Bur. Mines Inf. Circ. 8475, 134 p., tables, 1970.

Analyses for helium and other components are reported for 390 samples of natural gas collected as part of a continuing survey of helium resources of the free world. Samples include 327 from gas and oil wells in 21 states, 8 from wells in 3 other countries, 49 from pipelines in 11 states, and 6 from foreign pipelines. — ERL

Carlson, P. R. *See* Nelson, C. Hans. 03532

03078 **Carlson, Paul R.; Alpha, Tau R.; McCulloch, David S.** The floor of central San Francisco Bay: California Div. Mines and Geology Mineral Inf. Service, v. 23, no. 5, p. 97-107, illus., tables, 1970.

Acoustic subbottom profiling of San Francisco Bay was done by the U.S. Geological Survey to obtain the configuration of the buried bedrock surface and to examine the sediments beneath the bay floor. Using data from a high-resolution boomer and a sparker system, combined with sediment sampling, gravity coring and a physiographic diagram, the morphology of the bay floor was portrayed. The three morphologic subdivisions, the Golden Gate, central bay, and Raccoon Strait are described. Where current and wave-energy levels are low, as in Richardson Bay and Berkeley mud flats, the thick sequence of sediments is predominantly silt and clay. In the central bay sand predominates and sediment thickness reaches > 250 feet, but beneath Golden Gate Bridge, in the highest energy environments, the bedrock is swept clean of sediments. An upper unit of sediments rests unconformably on a lower one. — EH

03248 **Carman, John Homer.** The study of the system $NaAlSiO_4$-Mg_2SiO_4-SiO_2-H_2O from 200 to 5,000 bars and 800°C to 1100°C and its petrologic implications [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5167B, 1970.

Carmichael, I. S. E. *See* Stormer, J. C., Jr. 03172

03177 **Carmichael, I. S. E.; Nicholls, J.; Smith, A. L.** Silica activity in igneous rocks: Am. Mineralogist, v. 55, nos. 1-2, p. 246-263, illus., table, 1970.

In igneous rocks the occurrence of such mineral pairs as leucite and sanidine, or nepheline and albite indicates that silica activity may be buffered over a range of temperatures. The variation of silica activity with temperature for these and other reactions are calculated. On a basis of two boundary reactions, three broad groups of magma series are distinguished: tholeiitic, alkali olivine basalt, and feldspar-free rocks. — JWC

Carozzi, Albert V. *See* Jansa, Lubomir F. 03603

03249 **Carr, Donald Dean.** Geometry and origin of oolite bodies in the Ste. Genevieve Limestone (Mississippian) in the Illinois basin [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5097B, 1970.

03636 **Carr, M. H.** Atmospheric collection of debris from the Revelstoke and Allende fireballs: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 689-700, illus., tables, 1970.

In two separate events, Revelstoke and Allende, the air through which a fireball had been observed to pass was sampled for meteoritic debris. From Revelstoke, a highly distinctive assemblage of particles was collected, including large numbers of magnetite spherules, transparent siliceous spherules, and several types of irregular nickel-bearing particles. The Allende collections yielded only slightly more magnetite and siliceous spherules than background and no nickel-bearing particles. Revelstoke and Allende are believed to represent two different types of events. In Revelstoke type, large amounts of meteoritic debris are left in the atmosphere, and little reaches the ground in large coherent fragments; in Allende type, little material remains in the atmosphere, but large fragments reach the ground in the fall areas. — *from* Author's abstract

Carrillo, Fred V. *See* Kingston, Gary A. 03208

03077 **Cartwright, Keros.** Groundwater discharge in the Illinois basin as suggested by temperature anomalies: Water Resources Research, v. 6, no. 3, p. 912-918, illus., table, 1970.

To test the hypothesis that areas where ground water is moving vertically should be reflected by temperature anomalies, an isothermal map based on bottom-hole temperatures was compared with a theoretical map made by projecting temperature gradients downward from the surface. The residual temperature map made on the basis of this comparison shows several warm and cool anomalies that are postulated to be discharge and recharge areas respectively. Curvature of the earth's thermal profile for the basin suggests that 59,000 acre-feet of ground water per year are discharged upward. This agrees with an estimated ground-water discharge into streams of 43,000 acre-feet. From a simplified model of the basin, an inflow of 36,500 acre-feet from the highlands is estimated. A significant part of this must be through fracture zones associated with faults and anticlines, as the shales are not permeable enough for this large a flow. — *from* Author's abstract

Case, D. R. *See* Laul, J. C. 03651

03250 **Caslavsky, Jaroslav Ladislav.** Dislocation structures and the mechanical properties of mica [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5098B, 1970.

Castle, Robert O. *See* Youd, T. Leslie. 03626

03518 **Caswell, Charles A.** Underground waste disposal — Concepts and misconceptions: Environmental Sci. and Technology, v. 4, no. 8, p. 642-647, illus., 1970.

Deep-well disposal originated with the petroleum industry as a means of disposing of salt water. Some of the advantages and disadvantages of subsurface techniques to water resource problems under good geologic conditions are listed. The rate of fluid migration in geologic formations is discussed, and several mechanical factors involved in fluid flow in subsurface formations are listed. More knowledge in this whole area is needed. — ESL

Cathro, R. *See* Brown, A. Sutherland. 03464

03453 **Cavalero, R. A.** Geology of the Anaconda Caribou deposit, Restigouche County, N.B. [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 281, 1970.

03251 **Cavaroc, Victor Viosca, Jr.** Geology of some Carboniferous lower deltaic plain sediments of western Pennsylvania [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5098B, 1970.

Chan, L. H. *See* Bertine, K. K. 03641

03578 **Chandra, Umesh.** Analysis of body-wave spectra for earthquake energy determination: Seismol. Soc. America Bull., v. 60, no. 2, p. 539-563, illus., tables, 1970.

This study determines body wave spectra of earthquake signals for estimation of energy in seismic waves by taking into account the radiation pattern of the source, effect of geometrical spreading and absorption in the earth's mantle, effect of crustal structure under the receiver, and response of recording instruments. Focal mechanism solutions of one intermediate and four deep focus earthquakes analyzed have been determined using P-wave first motion directions and S-wave polarization angles. All mechanism solutions conform to a double couple source model. Basic equations for estimating energy in body waves from the spectra equalized to the source are discussed. The ratio E_p/E_s varies between 0.008 to 0.106 for the frequency range 0.005 to 0.205 cps. The possibility of a small tensile component accompanying shear faulting is indicated. — Author's abstract

03693 **Chandra, Umesh.** Correction for focal mechanism in body-wave magnitude determination: Jour. Geophys. Research, v. 75, no. 17, p. 3421-3430, tables, 1970.

A method is developed for considering the effect of the radiation pattern on body-wave magnitude determination. Focal mechanism solutions of one intermediate and four deep-focus earthquakes analyzed in this study were determined from P-wave first-motion directions and S-wave polarization angles; all conform to a double-couple source model. Magnitudes are computed from data at different stations for each of the earthquakes. Application of the method to data of the five earthquakes studied by using Duda's Q values (1969) reveals definite improvements in determination of magnitudes from the vertical component of P-waves. The method does not improve results of magnitude determinations from horizontal components of S-waves. A more accurate chart of Q values as a function of depth and epicentral distance is needed. — DBV

03720 **Chandra, Umesh.** Comparison of focal mechanism solutions obtained from P- and S-wave data: Jour. Geophys. Research, v. 75, no. 17, p. 3411-3420, illus., tables, 1970.

Focal mechanism solutions for one intermediate and four deep-focus earthquakes have been determined independently from S-wave polarization data and P-wave spectrums equalized to the source, without any regard to the P-wave first-motion data. Equal-area projections of the nodal lines corresponding to the two solutions, together with the P-wave first motion and S-wave polarization data, are presented for each earthquake. Comparison of results obtained with the two methods shows excellent agreement for three earthquakes and good for the other two. For all earthquakes, P-wave first-motion directions are in good agreement with respect to solutions obtained by either of the methods. The analysis reaffirms the possibility of using either S-wave polarization data or P-wave spectrums equalized to the source as an independent method for focal mechanism determination. — *from* Author's abstract

03093 **Chang, Chin-Yung.** Finite element analyses of soil movements caused by deep excavation and dewatering [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4605B-4606B, 1970.

Chao, G. Y. *See* Hounslow, A. W. 03502

03252 **Chen, John Teh-Jen.** A rheological stress-strain-time relationship for Seattle soils [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5033B, 1970.

Cheney, E. S. *See* Vredenburgh, L. D. 03206

03383 **Cherry, R. N.; Stewart, J. W.; Mann, J. A.** General hydrology of the Middle Gulf area, Florida: Florida Bur. Geology Rept. Inv. 56, 96 p., illus., tables, 1970.

The Middle Gulf area in the west-central coast of peninsular Florida is part of a large hydrologic system; no permanent regional declines in surface or ground-water levels have occurred. Chemical quality of ground and surface water is good; near the coast the mineral content of both surface and ground water may approach or be the same as that of sea water. Ample supplies of good quality water are available for existing and foreseeable uses. The present problem is one of water management and optimum development. — *from* Authors' abstract

Chesterman, W. D. *See* Loring, D. H. 03707

Chesters, Gordon. *See* Keeney, Dennis R. 03330

03677 **Christensen, M. N.; Gilbert, C. M.** Reply [to "Structure of Mono Basin, California," by L. C. Pakiser (1970)]: Jour. Geophys. Research, v. 75, no. 20, p. 4081-4082, 1970.

For the original paper, *see* ibid., p. 4077-4080.

03475 **Christie, R. L.** The Arctic islands, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 693, p. 31-33, 1970.

The area considered includes land and sea areas of the archipelago and adjacent continental shelf, except for the Shield areas of Baffin Island and Melville and Boothia Peninsulas. The Paleozoic sequence of the Franklin geosyncline includes beds as young as Devonian, and is overlain to the northwest by the Sverdrup basinal sequence, Mississippian to early Tertiary. The history of earth science research in the Arctic islands is summarized. Present activity includes: field study of exposed rocks, geophysical surveys, and cores and logging data from exploratory wells. Early and detailed knowledge of the stratigraphy and biostratigraphy of the basins is needed. A longer-range objective is understanding of the regional geology and tectonics of the archipelago, adjacent ocean basins, and Greenland. Five recommendations toward attaining these objectives are listed. — ESL

03117 **Chukhrov, F. V.** Analogues of flint clays in Soviet literature [with French, German and Russian abs.]: Clays and Clay Minerals, v. 18, no. 1, p. 1-5, illus., table, 1970.

The term flint clay used in several countries corresponds closely to the Russian sukhar, toasted-bread clay. In both U.S.A. and U.S.S.R., typical occurrences are confined to lower Carboniferous deposits. Properties and occurrence of toasted clays of the Borovichy deposit are similar to the flint clays of Missouri, except in having lower bulk specific gravity and higher porosity than the Missouri clays; varieties with excess free alumina are observed in both. The term toasted complex is suggested, which corresponds to W. D. Keller's flint clay facies. Clays of the complex are sediments of ancient swamps and lakes with rich vegetation; their source material was dispersed silicate particles transported from land. Their structure and properties are explained by precipitation of kaolinite as colloidal clumps in which crystallization occurred with formation of intimate intergrowths and variously oriented segregations. — *from* Author's abstract

03253 **Chute, John Lawrence, Jr.** Polarization studies of geomagnetic rapid variations [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5098B-5099B, 1970.

03506 **Clark, Alan H.** Quantitative determination of hexagonal and monoclinic pyrrhotites by X-ray diffraction — A discussion [of paper by A. R. Graham, 1969]: Canadian Mineralogist, v. 10, pt. 2, p. 278-280, 1970.

For the original paper, *see* ibid., v. 10, pt. 1, p. 4-24, 1969; Abs. North American Geology, March 1970.

03574 **Clark, John; Guensburg, Thomas E.** Population dynamics of *Leptomeryx*: Fieldiana – Geology, v. 16, no. 16, p. 411-451, illus., tables, 1970.

Large, carefully-documented collections of middle Oligocene fossils made in connection with paleogeographic studies constitute death assemblages accumulated over a period of time and buried without transportation. *Leptomeryx* was selected for study because it is monospecific within the Scenic Member of the Brule Fm. of South Dakota. A collection from Sioux County, Nebraska, was included for comparison. Data on 392 specimens from three collections are given, and six age stages are set, based on wear on the three lower molars. Full size was attained in six to eight months and the total life span was about eight years; over half the individuals died in early maturity. Several possible causes of death are ruled out, and epidemic disease is found to fit the evidence perfectly; repetition every few years would explain both the catastrophic death and the youth of the population. Assemblages of *Hypertragulus* exhibit the same phenomena. — ESL

Clark, L. A. *See* Petruk, W. 03494

03386 **Clarke, D. B.** Tertiary basalts of Baffin Bay, possible primary magma from the mantle: Contr. Mineralogy and Petrology, v. 25, no. 3, p. 203-224, illus., tables, 1970.

New analyses show that Tertiary tholeiitic basalts from the Baffin Bay area have generally primitive characteristics. Comparison of the bulk chemical compositions of the basalts with material of known phase relation suggests that these basalts have properties intermediate between investigated natural and synthetic compositions. A dis-

crete group of these basalts coincides in projection with the composition of the liquid produced by the partial melting of garnet peridotite at 30 kb. The compositions in this group are believed to be parental to the other rocks in the province principally through a mechanism of olivine fractionation. Eclogite fractionation is invoked to account for the chemical differences between the two suites of basalts in Baffin Bay. — Author's abstract

03384 **Clayton, Lee.** Geologic map of Dunn County: North Dakota Geol. Survey Misc. Map 11, scale [1:125,000], text, 1970.

Map units described in the text range from the Paleocene Sentinel Butte Formation, Eocene Golden Valley, Miocene Arikaree, to Pleistocene Coleharbor, in addition to Pleistocene and Holocene sediments. Surface drift is designated Napoleon(?) drift as it resembles that in south-central North Dakota. The westernmost glacier-margin channel is the Killdeer-Glen Ullin channel which lies everywhere just west of the Napoleon(?) drift limit; these channels formed when proglacial lakes spilled across divides, cutting into the Sentinal Butte Formation and causing catastrophic flooding. Boulders west of the Napolean(?) drift are residual remnants of the pre-Wisconsin Dunn drift. The Kildeer Mts. are flanked by remnants of pediments which are capped by 5-10 feet of gravel and are probably early Wisconsin in age. The change from glacial to nonglacial climate must have occurred about the time the Killdeer-Glen Ullin channel was formed. Pleistocene erosion history is summarized. — MCM

03360 **Cleary, John; Hales, Anton L.** PKIKP residuals at stations in North America and Europe: Earth and Planetary Sci. Letters, v. 8, no. 4, p. 279-282, illus., table, 1970.

Station corrections can be determined very accurately from observations of PKIKP, because the effects of mislocations and of station azimuthal variations are minimized. A preliminary study of PKIKP station corrections from bulletin data confirms the relative values of the P corrections found by Cleary and Hales for stations in North America and Europe. — Authors' abstract

03546 **Clendening, John A.** *Laevigatosporites dunkardensis*, new name for *Laevigatosporites plicatus* Clendening, 1969: Jour. Paleontology, v. 44, no. 4, p. 788, 1970.

Laevigatosporites plicatus Clendening 1969, for a Pennsylvanian spore from the Dunkard Group, West Virginia, is a later homonym of *L. plicatus* Kar 1968, and is replaced by the new name *L. dunkardensis* Clendening 1970. — SHM

03047 **Clough, Ray W.** Earthquake response of structures, Chap. 12 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 307-334, illus., 1970.

The theory of structural dynamics, applied to calculation of vibratory response to earthquake ground motions, predicts stresses and deflections that will be developed in any given structural system as a result of any specified ground motion history applied at the base. Single-degree-of-freedom and multidegree-of-freedom systems are considered. In the former the earthquake response may be obtained by application of the Duhamel integral, and in the latter by the mode superposition method. Since the latter is based on the principle of superposition, it cannot be used in analysis of a nonlinear structure, i.e. any structure stressed beyond the elastic limit. Since most major earthquakes cause significant overstress in standard multistory buildings, the most convenient technique for evaluating the dynamic response is a step-by-step integration procedure; this procedure is discussed and illustrated by an actual example. — VSN

03033 **Cluff, Lloyd S.** The Caracas earthquake and Salt Lake City, *in* Governor's conference on geologic hazards in Utah, December 14, 1967: Utah Geol. and Mineralog. Survey Spec. Studies 32, p. 7-10, illus., 1970.

The Caracas, Venezuela, earthquake of July 29, 1967, has significance for Utah because geological and seismological conditions of Salt Lake City and Caracas are

similar. Probable consequences of a 7.5 magnitude earthquake along the Wasatch fault are damage to buildings, and possibly the water supply and gas mains of Salt Lake City; structures not designed to resist shaking would be damaged and might collapse; landsliding, liquifaction and settlement would occur in areas where surficial geologic and soil conditions were contributing factors and where engineering design and construction have not considered these factors. Suggestions to minimize chances of damages are made. — MCM

03321 **Coates, Donald R.** Mastodon bone in Bradford Co.: Pennsylvania Geology, v. 1, no. 6, p. 4-5, illus., 1970.

A pelvic fragment of a mastodon, *Mammut americanus*, an extinct type of elephant that roamed parts of North America during the last phases of the Ice Age, was discovered in a gravel pit in the Chemung River valley. A radiometric age indicates the mastodon died 13,320 ± 200 yr ago; only one in Sumter County, Alabama, is older. The bone was deposited by meltwaters from the Valley Heads ice sheet when the ice front stood several miles north of the site, indicating the glacial maximum of the last ice sheet in the region could not have occurred much more than 13,000 yr ago. — MCM

03283 **Coates, J. A.** Stratigraphy and structure of Manning Park area, Cascade Mountains, British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 149-154, 1970.

The Dewdney Creek and Pasayten Groups in the Manning Park area contain fossils of Early Jurassic to late Early Cretaceous ages. The Bathonian hiatus extends from early Middle to early Late Jurassic. The Neocomian hiatus extends from latest Jurassic to mid-Early Cretaceous. These intervals are represented by disconformities, the basis for a proposed subdivision of the Dewdney Creek Group. Rocks older than the Bathonian hiatus are assigned to the Ladner Group, Upper Jurassic strata to the Dewdney Creek Group, and strata younger than Necomian to the Jackass Mountain Group. The lower part of the Pasayten Group is also included in the Jackass Mountain. The various groups comprise coarse to fine clastic sedimentary rocks derived from volcanic, metamorphic, granitic, sedimentary and mixed terranes. Volcanism contributed much pyroclastic material to the Middle Jurassic section. — *from* Author's abstract

03608 **Cody, Robert D.** Anomalous boron content of two continental shales in eastern Colorado: Jour. Sed. Petrology, v. 40, no. 2, p. 750-754, illus., table, 1970.

Boron content and clay mineralogy were determined on samples from a continental facies of the Fountain Formation of Permo-Pennsylvanian age and a pre-Fountain fossil soil developed during late Mississippian time. All samples from both units were found to contain far more boron than amounts previously proposed as indicative of shales deposited in continental environments. The results of the study cast doubts upon the reliability of boron analyses of sedimentary rocks as an index of their depositional salinity. — Author's abstract

Coffman, Joseph S. *See* Kiilsgaard, Thor H. 03207

03470 **Coggon, J. H.; Morrison, H. F.** Electromagnetic investigation of the sea floor: Geophysics, v. 35, no. 3, p. 476-489, illus., 1970.

Numerical evaluation of integral expressions for the fields about a vertical magnetic dipole in the sea allows analysis of the electromagnetic response over wide ranges of sea induction number and sea-floor conductivity. The analysis made here indicates that a marine electromagnetic system could readily be designed, with such applications as oceanographic and geologic studies and mineral exploration. — DBV

03072 **Coleman, Neil L.** Flume studies of the sediment transfer coefficient: Water Resources Research, v. 6, no. 3, p. 801-809, illus., tables, 1970.

Flume experiments show that in open channel flow the sediment transfer coefficient increases with distance from the channel bed, reaching a maximum value at a distance from the bed equal to about 20 percent of the flow depth, and then tends to remain at a constant value up to the water surface. The experiments also yield evidence indicating that the sediment transfer coefficient is larger for larger particle sizes. — Author's abstract

03761 **Collett, L. S.** Resistivity mapping by electromagnetic methods [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 615-624, illus., tables; discussion, p. 624-625, 1970.

A review is made of the electromagnetic methods for soil and rock resistivity mapping on a regional scale using ground and airborne techniques. Radio waves have been used to produce soil conductivity maps of Canada and the United States and in the USSR for regional resistivity and geological mapping; VLF energy has been reported for mapping vertical conductors and faults; the AFMAG system has been employed for mapping large fault and shear structures, as in the Lake Abitibi-Noranda area, Quebec-Ontario. EM systems applied to search for ore deposits have been designed to minimize effects of conductive overburden; a great deal of regional geologic information can be obtained with or without modifications to equipment. The Barringer INPUT system has been modified for mapping resistivity changes in overburden to outline an aquifer in Manitoba, and to map contact between fresh and salt water in France. — *from* Author's abstract

Collings, R. K. *See* Wayman, R. A. 03742

Colquhoun, D. J. *See* Pierce, J. W. 03748

03536 **Conkin, James E.; Fuson, Michael L.** *Archimedes kentuckiensis*, a new fenestrate bryozoan from the Floyds Knob Formation (Upper Osagean) of Kentucky: Jour. Paleontology, v. 44, no. 4, p. 669-672, illus., tables, 1970.

Archimedes kentuckiensis, a new species of fenestrate bryozoan, is described from the Lower Mississippian Floyds Knob Formation of Jefferson and Marion Counties, northwestern Kentucky. *A. kentuckiensis* is stratigraphically the lowest known species of the genus from the Mississippian of Kentucky and, indeed, one of the oldest known species of *Archimedes*. Its closest affinities are with the Keokuk (Illinois) form, *A. negligens* Ulrich, 1890. — *from* Authors' abstract

03762 **Conley, James F.; Henika, William S.** Geology of the Philpott Reservoir quadrangle, Virginia: Virginia Div. Mineral Resources Rept. Inv. 22, 46 p., illus., geol. map, 1970.

The Philpott Reservoir quadrangle is located in parts of Franklin, Patrick, and Henry counties in the southwestern Piedmont of Virginia. The southeastern part of the quadrangle is underlain by schist, gneiss and amphibolite of uncertain age, and the northwestern part by Moneta gneiss and Lynchburg Formation, the latter unconformably overlying the former and composed of five lithologies: metagraywacke, muscovite-sericite and muscovite-biotite schist, metabasalt, graphite schist, and muscovite-chlorite-chloritoid schist. The Lynchburg was intruded by diabase dikes and gabbro sills now metamorphosed. Both it and rocks of uncertain age were intruded by felsite dikes and Triassic diabase dikes. Of two major fold systems present, the southeastern one is separated from the northwestern one by a high-angle thrust fault. Crushed stone, mica, iron ore and gem stones have been produced in the quadrangle. — *from* Authors' abstract

Conley, Robert F. *See* Lloyd, Mary K. 03120

03760 **Conn, H. M. K.** Geophysics and asbestos exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 485-491, illus., 1970.

This paper treats only exploration for chrysotile asbestos in ultrabasic rocks. Magnetic surveys remain the principal geophysical tool for discovery, delineation, and structural study of ultrabasic bodies. Interpretation of rock types, fault structure, and associated anomalies, followed by drilling through overburden, has resulted in the discovery of a number of asbestos prospects. Electromagnetic surveys have produced erratic conductor patterns difficult to explain. Brief case histories with diagrams provide examples of both types of surveys. Ultrabasic bodies are commonly assumed to be magmatic intrusions. An extrusive volcanic origin for many ultrabasic rocks, especially within volcanic piles, now appears probable to the writer. This hypothesis provides numerous geological possibilities in connection with petrology, emplacement, age relations, and ore genesis. It broadens the scope for correlating geophysical results with ore occurrences. — Author's abstract

03029 **Cook, Donald G.** A Cambrian facies change and its effect on structure, Mount Stephen-Mount Dennis area, Alberta-British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 27-39, illus., table, geol. map, 1970.

This paper is a summary of the structural relationships associated with a facies change from east to west in the Middle and Upper Cambrian strata of the Main Ranges of the Rocky Mountains of Canada, investigated during the summers of 1964 and 1965. In the western Main Ranges, with dominantly shale (slate) facies, the Chancellor Formation includes Middle and Upper Cambrian rocks, with strata at least twice as thick as their correlatives in the eastern Main Ranges, which have dominantly carbonate facies. A table correlating the formations of the two facies is included. The author dismisses the concept of the Stephen-Dennis fault as a divider of the two facies, since strata can be traced unbroken from one facies into the other at four localities. — EH

Cook, Donald G. *See* Norris, D. K. 03477

03037 **Cook, Kenneth L.** Earthquake hazards in Utah, *in* Governor's conference on geologic hazards in Utah, December 14, 1967: Utah Geol. and Mineralog, Survey Spec. Studies 32, p. 22-27, illus., tables, 1970.

Utah lies on a north-trending part of a belt of seismicity extending from the East Pacific Rise to British Columbia; fault zones are Hansel Valley, East Cache, Wasatch, Thousand Lakes, Sevier-Tushar (or Elsinore), and Hurricane. From 1950 through June 1965, at least 609 earthquakes occurred in Utah, and 38 or more were damaging. More than 90 percent were along or in association with the known fault zones. Installation of a more complete network of permanent seismograph stations in 1962 is a major step in earthquake detection and in studying their effects by defining active seismic areas. Two horizontal quartz-type 100-ft long strainmeters have been installed in Salt Lake County, and additional equipment is planned. Suggestions are made for preventive measures relating to possible damage, further research, and regulations regarding design of buildings, dams, and bridges. — MCM

Cooper, Hilton H., Jr. *See* Pinder, George F. 03074

Cordova, R. M. *See* Sumsion, C. T. 03063

03154 **Correa, Aderbal Caetano.** Borrego Pass Lentil, a new member of the Crevasse Canyon Formation, southern San Juan basin, New Mexico: Mtn. Geologist, v. 7, no. 2, p. 99-102, illus., 1970.

A conspicuous sandstone unit in the Crevasse Canyon Formation in Casamero Lake quadrangle, McKinley County, New Mexico, is herein named Borrego Pass Lentil from outcrops approximately 4.2 miles southwest of Borrego Pass, near the westernmost boundary of the Borrego Pass quadrangle. This sandstone lentil has been designated by Sears, Hunt, and Hendrix (1941, p. 113) [U.S. Geol. Survey Prof. Paper 193-F] as the "stray sandstone" (informal usage). The Borrego Pass Lentil overlies the Dilco Coal Member of the Crevasse Canyon Formation and is overlain by the Mulatto Tongue of the Mancos Shale. — Author's abstract

03671 **Costain, John K.** Probe response and continuous temperature measurements: Jour. Geophys. Research, v. 75, no. 20, p. 3969-3975, illus., 1970.

A platinum temperature transducer moving at a constant speed in a drill hole gives a temperature that is the convolution of the true temperature and the impulse response of the transducer. The true temperature function appearing in the convolution integral can be determined by inverse filtering, and accurate thermal gradients can be obtained by using moving probes that are not in thermal equilibrium. Layered sections composed of layers 1-15 m thick, with thermal conductivities varying from 5-15 mcal per cm sec °C were synthesized. Large apparent heat-flow anomalies associated with a probe not in equilibrium and moving through the layered media at a constant speed of 0.5 mps were examined. From a laboratory determination of the time response of the probe to a step change in temperature, an inverse filter can be designed that, when convolved with the measured temperature profile, gives the true temperature and thus gives correct thermal gradients. — *from* Author's abstract

03254 **Couch, Richard William.** Gravity and structures of the crust and subcrust in the northeast Pacific Ocean west of Washington and British Columbia [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5107B-5108B, 1970.

03392 **Cox, Allan.** Palaeolatitudes from JOIDES deep sea sediment cores: Nature, v. 226, no. 5249, p. 934-935, illus., 1970.

The cores recovered on station 10 during Leg II of the JOIDES deep-sea drilling program, on which the paleomagnetic measurements were made, separate naturally into five groups which after cleaning have absolute values of inclination which are consistent within each group but different between groups. The mean value for each group decreases with increasing depth in the core. Plotted against age, the mean paleolatitudes decrease uniformly from near lat 32.9° N to 19.6° N. The inclination for the Cretaceous field at station 10, predicted from plate tectonic concepts, is 36°; the observed value is 35.5°. Though this does not prove that the North American plate comprising the northwestern Atlantic Ocean and the American continent has remained rigid for the past 80 m.y., it is consistent with that assumption. — DBV

03084 **Cox, Gordon L.** Zama reef model predicts reservoir performance: Oilweek, v. 21, no. 26, p. 2, 4, 7, illus., 1970.

Although producing Keg River pinnacle reefs of the Zama area in northern Alberta have a combined estimated 280 million barrels of recoverable oil, they are essentially "one well, one pool" structures. A composite reef model made from seismic and well data can be utilized to good effect. A detailed study of 3,764 feet of Zama and Keg River core was completed and nine mappable lithofacies were found to explain all the rock descriptions. A three-dimensional lithofacies model was constructed which shows that the organic reef makes up 16 percent of the total reef mass. Higher permeability and porosity show up in the dolomitized facies. — ESL

03228 **Coyle, Harry M.; Gibson, Gary C.** Empirical damping constants for sands and clays: Am. Soc. Civil Engineers Proc., v. 96, paper 7296, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 949-965, illus., 1970.

Results of a laboratory investigation of damping properties of saturated sands and clays of relatively high plasticity are reported. Effort is made to relate these damping properties to common physical properties of various soils by a series of dynamic and static tests. The sands varied in grain size and grain shape, and clays in plasticity and moisture content. Velocity of sample deformation, peak dynamic loads, and peak static loads were measured so that damping constants for all the soils could be evaluated; a mathematical model used in wave equation studies of piling behavior is modified to achieve a constant damping value over the full range of loading velocities. The damping constant is related to void ratio and effective angle of internal shearing resistance in sands, and moisture content and liquidity index in clays. — *from* ASCE abstract

03393 **Cracraft, Joel.** Mandible of *Archaeopteryx* provides an example of mosaic evolution: Nature, v. 226, no. 5252, p. 1268, illus., 1970.

Evidence is presented to show that the lower jaw of *Archaeopteryx*, like other morphological structures in transition forms, is composed of both primitive and advanced characters and is therefore a good example of mosaic evolution. It is not strictly reptilian in structure and thus indicates that the skull as a whole may be more advanced toward the avian level of organization than previously suggested. — DBV

03197 **Cramer, Fritz H.; Díez de Cramer, María del Carmen R.** Rejuvenation of Silurian chitinozoans from Florida [with Spanish Abs.]: Rev. Española Micropaleontologia, v. 2, no. 1, p. 45-54, illus., 1970.

Well-preserved chitinozoans occur in great abundance in Ordovician and Silurian subsurface material of north-central Florida. Morphological characteristics of Wenlockian specimens [recovered from a black shale] are discussed: the role of the prosome in rejuvenation [division, or growth of multi-unit chains]; rejuvenation of ancyrochitinid chitinozoans; and rejuvenation of desmochitinid chitinozoans. It is concluded that, at least in ancyrochitinids, morphologic changes of the prosome are probably unrelated to the process of rejuvenation. However, as reported (Taugourdeau, 1964) and confirmed here, in desmochitinids the prosome seems to control the rejuvenation; apparently every unit, not only the first one, retained the capacity for rejuvenation. — *from* Authors' abstract

03115 **Crane, Robert Lee.** A study of the crystal structure of långbanite [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4728B, 1970.

03479 **Crawford, Arthur Raymond.** Continental drift and un-continental thinking: Econ. Geology, v. 65, no. 1, p. 11-16, illus., 1970.

A synoptic approach to Earth history is now made much easier as a result of acceptance of the theory of continental drift following additional evidence mainly from paleomagnetic and marine geophysical and geological work. The value of this approach for mineral search is illustrated by examples chosen from India, Ceylon and Australia. Many aspects of such search necessitate recognition of the earlier close association of geological features now widely separated geographically. Continents can no longer be studied effectively in isolation. — Author's abstract

03399 **Cressy, Philip J., Jr.** Multiparameter analysis of gamma radiation from the Barwell, St. Séverin and Tatlith meteorites: Geochim. et Cosmochim. Acta, v. 34, no. 7, p. 771-779, illus., tables, 1970.

Cosmogenic gamma-emitting radionuclides in the three stone meteorites were measured shortly after fall in a nondestructive gamma-gamma coincidence counting system. The location of the pre-atmospheric surface of the St. Séverin is confirmed. Activity ratios in the three are compared with nine published analyses of other freshly-fallen stone meteorites. From Be-10/Al-26 activity ratios, the specimens are arranged in order of increasing low-energy spallation depths. In the least-shielded samples the Sc-46/Mn-54 ratio is three times larger than expected, as are the Cr-51/Mn-54 ratios in the unshielded sample. The relative enrichment in Cr-51 and Sc-46 is explained by a low-energy solar flux. The Co-60 surface enrichment is taken to suggest a history of exposure to solar flares. — GV

03056 **Crippen, J. R.; Pavelka, B. R.** The Lake Tahoe basin, California-Nevada: U.S. Geol. Survey Water-Supply Paper 1972, 56 p., illus., table, 1970.

This lake, in the northern part of a 40 × 10-18 mi basin, is 500-1,200 feet deep, and the water is exceptionally clear. During the Paleozoic a shallow arm of the sea lay where the Sierra Nevada and Carson Range now rise. Mountain ridges formed during the Nevadan Revolution and were worn down by erosion. A period of great volcanic activity followed, and then, during the late Tertiary, the Sierra Nevada block was tilted upward and the Tahoe graben dropped down. The lake outlet was blocked at times by basalt flows and later by glaciers. Rocks are mostly igneous and metamorphic, and most of the ground water is found in valley fills of coarse soil. The history of exploration, settlement, and land and water use is reviewed. The annual hydrologic budget of the basin and its limnology are discussed; the greatest danger is from eutrophication due to sewage. — ESL

03315 **Croft, M. G.** Ground water basic data, Mercer and Oliver Counties, North Dakota: North Dakota Geol. Survey Bull. 56, pt. 2 (North Dakota Water Comm. County Ground Water Study 15), 268 p., illus., tables, 1970.

Basic data included in this report, collected chiefly between 1966 and 1969, consists of: data on about 1,300 wells and test holes, data on 9 springs, water-level measurements in 29 observation wells, logs of 299 test holes and selected wells, chemical analyses of 160 water samples, and 25 particle-size distribution curves. A map in pocket shows location of wells, springs, and test holes. — MCM

03747 **Cronin, John F.** Radiometric studies, Bay of Fundy: Maritime Sediments, v. 5, no. 3, p. 119-122, illus., 1969 [1970].

Mineral and petrologic components of the lithospheric surface, a reflector of radiation, show a wide range of spectral characteristics. The first detailed studies of interrelated optical properties at various geologic sites in different atmospheric environments, along the west shore of Minas Basin, Nova Scotia, were limited to measuring reflectivity and polarization and to elementary spectrophotography of variegated Triassic sedimentary beds. Paddy Island is an erosion stack of the Wolfcamp formation, capped at each end by resistant red Blomidon beds. One lithic unit, reflective at all wavelengths, is more indurated than others, orange-red rather than their deeper red, and contains considerably more calcite (25 percent). Unexplained denser encrustation of sea-spray salts is believed the reason for its anomalous reflectivity. Rippled sand derived from the Triassic beds is also orange-red and exhibits an increased reflection. — GDC

03694 **Cruden, D. M.** A theory of brittle creep in rock under uniaxial compression: Jour. Geophys. Research, v. 75, no. 17, p. 3431-3442, illus., table, 1970.

Scholz's theory of brittle creep is rejected. A new theory based on Charles's theory of the subcritical growth of pre-existing cracks in the specimen by stress-sided corrosion is put forward. It is a successful explanation of new experiments on the creep of Pennant sandstone and Carrara marble under uniaxial compression at room temperatures. — Author's abstract

03293 **Culberson, Charles; Pytkowicz, R. M.; Hawley, J. E.** Seawater alkalinity determination by the pH method: Jour. Marine Research, v. 28, no. 1, p. 15-21, tables, 1970.

The coefficient f_H, used in the seawater alkalinity method of Anderson and Robinson (1946), has been redetermined at 25°C. We have found that $f_H = 0.741 \pm 0.005$ for salinities between 30 percent and 41 percent. The effect of the formation of HSO_4^- and HF of f_H and on the hydrogen-ion concentration is discussed; the apparent dissociation constants of HSO_4^- and HF are given for the salinities 26.7 percent and 24.6 percent at 25°C. — Authors' abstract

03349 **Cullers, Robert L.; Medaris, L. Gordon, Jr.; Haskin, Larry A.** Gadolinium, distribution between aqueous and silicate phases: Science, v. 169, no. 3945, p. 580-583, illus., table, 1970.

Studies of the partition of trivalent gadolinium between aqueous and silicate phases have been made at temperatures from 800° to 900°C and at pressures from 500 to 1000 bars. Constant values for the distribution coefficients for forsterite, enstatite, and diopside were obtained over a concentration range from 0.6 part per billion to 4 parts per thousand in the solid phases. Ratios of silicate crystal-aqueous phase distribution coefficients to silicate melt-aqueous phase distribution coefficients are close to the values for silicate crystal-silicate melt distribution coefficients estimated from natural systems. The free ion activity of trivalent gadolinium in the silicate melts appears to be less than one-hundredth of its value for aqueous phases of the same concentration. — Authors' abstract

03169 **Cummings, John P.; Simonsen, Stanley H.** The crystal structure of calcium niobate ($CaNb_2O_6$: Am. Mineralogist, v. 55, nos. 1-2, p. 90-97, illus., tables, 1970.

Calcium niobate, $CaNb_2O_6$, crystallizes in the space group *Pbcn*; lattice parameters are given. The measured density using the displacement method is 4.70 g/cc, and the density calculated assuming four formula weights per unit cell was 4.78 g/cc. The structure was determined by the heavy atom method, and the R value is 6.7 percent for 618 observed reflections. The structure consists of calcium and niobium atoms surrounded by oxygen atoms in a polyhedral arrangement. The polyhedra share corners and edges to form a chain-like network throughout the solid. — *from* Authors' abstract

03290 **Curl, Rane L.** Specific-gravity identification of aragonite: Natl. Speleol. Soc. NSS News, v. 28, no. 2, p. 18-19, illus., 1970.

A simple and inexpensive technique for identifying aragonite depends on the fact that atoms in aragonite are more closely packed than those in calcite, giving it a higher specific gravity (2.95) than calcite (2.72). When samples are placed in bromoform, specific gravity 2.85, the aragonite will sink and calcite will float. When 22 specimens identified as aragonite were tested in bromoform, 12 floated, and when they were identified by X-ray diffraction, only one was found to be aragonite, very porous, and eight were calcite pseudomorphs after aragonite. Minute samples may be used, and the bromoform can be recovered. — ESL

03391 **Currie, K. L.** New Canadian cryptoexplosion crater at Lake St. Martin, Manitoba: Nature, v. 226, no. 5248, p. 839-841, illus., 1970.

Geological data for the Lake St. Martin area are summarized and interpreted in a sketch map and section. A central core of crystalline Precambrian rocks is surrounded by a shallow annular basin of gypsum resting on fragmental rocks of Permian age which grade outward into near massive igneous latites. In the outer parts of the structure these rest on disturbed Paleozoic carbonate rocks. An uplifted rim is present around the igneous rocks, locally exposing Precambrian rocks. Shock metamorphic phenomena are present in specimens from the Precambrian core. The Lake St. Martin structure appears to be a typical Canadian cryptoexplosion structure of the resurgent type. It is the third crater whose location along "welts" on the Precambrian shield was predicted before discovery. The probability that three structurally and petrographically unusual craters would appear at the predicted sites in the course of less than 100 m.y. as the result of random impact of cosmic missiles seems negligible. — DBV

Dabiri, Hassan. *See* Green, Don W. 03073

03565 **Darnley, A. G.** Airborne gamma-ray spectrometry: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 145-154, illus., tables, 1970.

Equipment has been designed to provide high count rates in order to minimize statistical uncertainty, this being essential to justify applying terrain clearance and Compton scattering corrections to the data. Correction factors have been determined experimentally and can be applied automatically. Considerable ground work has been undertaken in parallel with equipment development in order to determine field parameters. Two airborne gamma-ray spectrometers are described; one is used in a helicopter and the other from a Skyvan aircraft. The former is being used to investigate the range of radiometric response from specific rock types, and for correlation of ground and air measurements; the latter has been tested, and began experimental surveys in 1969. Results are given to show comparative sensitivities of detector sizes; operational requirements for a gamma-ray spectrometer survey are discussed briefly. — *from* Author's abstract

Davey, C. B. *See* Losche, C. K. 03763

Davis, E. Mott. *See* Valastro, S., Jr. 03187

03376 **Dean, W. T.** Lower Ordovician trilobites from the vicinity of South Catcher Pond, northeastern Newfoundland: Canada Geol. Survey Paper 70-44, 15 p., illus., 1970.

Trilobites from limestone within volcanic rocks at localities near South Catcher Pond, southwest of Notre Dame Bay, are shown to be of Lower Ordovician, probably Arenig, age, and exhibit affinities with faunas in western Newfoundland, Quebec, and Sweden. At least four genera are present: *Geragnostus, Selenoharpes?, Leiostegium,* and *Ischyrophyma,* the last-named represented by *I. marmorea* sp.nov. The unnamed formation containing the fossils, previously considered to be of Silurian age, is provisionally reassigned to the Lush's Bight Group, for which a Lower Ordovician age had been established, though on the basis of meagre faunal evidence. — Author's abstract

03722 **Dear, P. S.** Isomorphism of åkermanite and strontio-gehlenite: Lithos, v. 3, no. 1, p. 13-16, table, 1970.

Phase equilibrium relations within the system åkermanite with strontio-gehlenite were investigated by solid state reaction techniques at 1250°C. Strontio-gehlenite is completely isomorphous with åkermanite. The tetragonal parameters of the solid solutions of the system are linear functions of molar compositions. The observed parameter changes for the system are compatible with the mechanism of isomorphous replacement ($2Ca^{2+} + Mg^{2+} + Si^{4+} \leftrightharpoons 2Sr^{2+} + 2Al^{3+}$) proposed for the solid solution series. — Author's abstract

03294 **Deep Sea Drilling Project.** (Scientific Staff). Deep Sea Drilling Project, Leg 10: Geotimes, v. 15, no. 6, p. 11-14, illus., table, 1970.

On Leg 10, 13 holes were drilled in the Gulf of Mexico, a deep-water basin since at least Late Cretaceous. Thick coarse sands, dominately turbidites, were encountered below the Miocene; pebbly sandstones in the middle Miocene are the coarsest yet recovered. The Pliocene is dominated by pelagic sedimentation, but in the Pleistocene, clastics again dominate. Natural gas occurred in all holes in the deep basin. A drill hole suggests that Sigsbee Scarp is a result of salt tectonics. On the Campeche Scarp, Early Cretaceous shallow-water dolomites were recovered; eastward along the scarp, cherts were encountered more frequently. Pelagic sediments comprise almost the entire Cenozoic and much of the Late Cretaceous. Late Cretaceous to Miocene radiolarian assemblages were recovered. Co-occurrence of radiolaria and calcareous microfossils in Paleocene and Eocene sediments is probably unique. — ESL

dela Cruz, Catalino del Rosario. *See* Silvester, Richard. 03740

03094 **delaCruz, Rodolfo Viloria.** The borehole deepening method of absolute stress measurement [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4606B, 1970.

Demenitskaya, R. M. *See* Grachev, A. F. 03449

03462 **Denham, G. M.** Instrumentation for airborne radiometric surveying [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 291, 1970.

Dennison, John M. *See* Jones, Michael L. 03598

03157 **Denton, G. H.; Porter, S. C.** Neoglaciation: Sci. American, v. 222, no. 6, p. 100-110, illus., 1970.

Mountain glaciers grow and shrink in response to small variations in climate. Periods of growth subsequent to the end of the Pleistocene are called neoglaciation. Study of historical records of mountain glaciers, historical records of the position of North Atlantic sea ice, dendrochronology, carbon-14 dating of vegetation, peat and soil overrun by glacier ice suggest that episodes of neoglaciation reached maxima about 5000, 2500, and 100 years ago. — DWR

deQuervain, M. *See* Federer, B. 03644

03570 **Der, Zoltan A.** Some data processing results for a vertical array of triaxial seismometers: Geophysics, v. 35, no. 2, p. 337-343, illus., table, 1970.

A vertical array of three component (triaxial) seismometers was operated in an abandoned oil well near Grapevine, Texas, in an experiment designed to test the effectiveness of teleseismic P-wave enhancement by utilization of all three components of motion at various depths within the well. Application of optimum multichannel filters to the horizontal components of the recordings produce traces having noise levels merely comparable to those measured at the deepest instruments. Reasons for this poor performance of optimum filters at Grapevine are assessed. The increase of the output signal-to-noise ratio relative to the surface recordings can be attributed mainly to the burial of instruments at this noisy site. Optimum filtering is still the best way to obtain relatively low noise deghosted output traces from the vertical array. — DBV

03712 **DeVore, George W.** Elastic compliances of minerals related to crystallographic orientation and elastic strain energy relations in twinned crystals: Lithos, v. 3, no. 3, p. 193-208, illus., table, 1970.

Principal elastic compliances and their related secondary compliances are calculated as a function of crystallographic orientation for common rock-forming minerals for a variety of stress conditions. Marked elastic anisotropy is present in the compliances; the compliances that have zero values for the standard orientation may have values in other orientations that contribute significantly to the preferred equilibrium orientation of the strained crystal. Twin individuals of strained crystals have different elastic strain energies for most orientations in the stress field and cannot be in equilibrium with each other except at certain orientations. The strain energy difference between twin individuals should result in twin boundary migration-recrystallization to eliminate one of the twins and thereby accounts for the observed absence or rarity of certain twins in tectonics. — Author's abstract

03061 **Dial, Don C.** Pumpage of water in Louisiana, 1970: Louisiana Geol. Survey and Dept. Public Works Water Resources Pamph. 26, 10 p., illus., table, 1970.

Surface- and ground-water pumpage are summarized by parish and category (public supply, industrial, thermoelectric, rural, irrigation). Total pumpage for all uses in 1970 is 9.1 bgd, a 35 percent increase over 1965 and 61 percent over 1960. Largest increases are in the industrial and thermoelectric categories. — MCM

03118 **Diamond, Sidney.** Pore size distributions in clays [with French, German and Russian abs.]: Clays and Clay Minerals, v. 18, no. 1, p. 7-23, illus., tables, 1970.

Knowledge of distribution of pore sizes in clay and soils is useful in microstructural characterization. Pore-size distributions and total porosity of some reference clays, naturally occurring subsoils, and commercial clay samples were determined by mercury porosimetry. Equivalent pore diameter ranged from several hundred microns to about 150A. The method and its assumptions are critically evaluated, and measurements of contact angle of mercury on clays yield values of 139° for montmorillonite and 147° for kaolinite and illite. Extent of shrinkage on oven-drying prior to mercury intrusion varies from insignificant to 30 percent of pore space. Development of techniques for water removal which do not involve change in pore structure is explored. Preliminary results for structurally weak saturated clays suggest that critical-region drying and perhaps freeze-drying may be practical. — *from* Author's abstract

03688 **Dickinson, William R.** Interpreting detrital modes of graywacke and arkose: Jour. Sed. Petrology, v. 40, no. 2, p. 695-707, illus., tables, 1970.

Subquartzose sandstones can be described adequately using 6 numerical grain parameters. Three primary parameters for quantitative serial designation of rock types are in the form $Q_zF_sL_z$, where Q is the total quartzose grains, F is the total feldspar grains, and L is the total unstable lithic fragments. Three secondary parameters permit refinements within each primary parameter: C/Q, where C is the total polycrystalline quartzose grains, P/F where P is the total plagioclase grains, and V/L where V is the total volcanic lithic grains. Stable grains, whose sum is Q, are essentially pure silica in mineralogy. Lithic fragments are subdivided at two levels into 4 main categories within which are various subcategories: volcanic fragments, clastic fragments, tectonic fragments, and microgranular fragments. Interstitial materials in-

clude exotic cements, homogenous, monominerallic, phyllosilicate cement, clayey lutum; recrystallized lutum, diagenetic epimatrix, and deformed and recrystallized lithic fragments. — *from* Author's abstract

03749 **Dietrich, R. V.; Hall, M. R.; Ragland, P. C.** Damming action of xenoliths and segregates within the Mount Airy "granite": Southeastern Geology, v. 11, no. 4, p. 205-214, 1970.

Mafic-poor microphaneritic zones up to a few cm thick occur directly beneath several xenoliths and some biotite-rich segregates within the Mount Airy granodiorite. Petrographic and bulk chemical analyses show that compared to the typical granodiorite most zones have finer grain size, lower percentages of feldspars and mafic minerals, higher percentages of quartz, lower Al, Ti, Fe, Mg, Ca, Sr, and Mn content and higher Si content. These zones and other analyzed rocks have Rb/Sr and Ca/Sr ratios notably smaller than for most granitic rocks. Electron microprobe analyses for 20 elements of several grains of coexisting quartz, plagioclase, microcline, biotite and muscovite from one zone and from typical granodiorite show that most minerals do not range significantly in composition. Mafic-poor zones represent differentiated material whose upward movement was stopped by damming action of xenoliths and segregates. — *from* Author's abstract

Díez de Cramer, María del Carmen R. *See* Cramer, Fritz H. 03197

Digby, P. J. *See* Murrell, S. A. F. 03318

03680 **Dillon, William P.; Zimmerman, Herman B.** Erosion by biological activity in two New England submarine canyons: Jour. Sed. Petrology, v. 40, no. 2, p. 542-547, illus., 1970.

Observations from *Deepstar 4000* in Block and Corsair Canyons indicate that, at present, erosion is predominantly biological. No evidence for large mass movements in the axis area of recent turbidity current activity was observed in either canyon. — Authors' abstract

03233 **Dionne, Jean-Claude.** Structures sédimentaires dans du fluvio-glaciaire, Lac-Saint-Jean, Québec [Sedimentary structures in stratified drift, Lac-Saint-Jean, Quebec (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 255-263, illus., 1970.

Disburbed strata occur in coarse fluvio-glacial sediments in the Lac-Saint-Jean area. Three major deformations in the western part of the area are bowl-shaped with internal layers bent downward, and are characterized by an arrangement of pebbles standing nearly vertically, and the presence of minor faults. They are collapse structures formed by the melting of buried ice shortly after the retreat of the ice-sheet. Two wedge-shaped structures occur in stratified drift at the southeast end of Lake Labrecque and near St. Ambroise. One resulted from infilling of a pseudotectonic opening in frozen sediments, the other from the melting of a buried ice-block with collapse of the upper layers. The structures are characteristic of ice-contact stratified drift and glacier ice-front deposits. They possibly developed when soil temperature was near 0°C but are not evidence of existence of a cold climate after deglaciation, 10,500-10,000 B.P. — *from* Author's abstract

03236 **Dionne, Jean-Claude.** Fentes en coin fossiles dans la région de Québec [Fossil ice wedges in the Quebec region (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 313-318, illus., 1970.

The discovery of fossil ice wedges in the area south of Quebec City is mentioned for the first time and structures are briefly described. The ice-wedge casts discovered in fluvioglacial sediments at an altitude of 155-156 m in the vicinity of the Highland Front Moraine, are dated about 12,500 to 11,500 B.P. — Author's abstract

03764 **Dionne, Jean-Claude.** Tidal-flat erosion and sedimentation by ice, St. Lawrence estuary [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 844, 1970.

03654 **Dirks, Richard A.; Busch, Carl R.** The giant boulders of the Iowan drift and a consideration of their origin: Iowa Acad. Sci. Proc. 1969, v. 76, p. 282-295, illus., tables, 1970.

Samples of the large granitic boulders of the Iowan drift were analyzed and features of the boulder distribution were examined. The analysis gave evidence of a central body of single granite stock which included more than 80 percent of all large boulders examined within the Iowan drift area. Characteristics of this main granite stock were then compared to the bedrock areas which could be considered source regions of the boulders. All evidence pointed toward a source region in the large granite body found in central and westcentral Minnesota. Weathering and structural features of the boulders suggested that they may have been formed by secular weathering prior to their glacial transport. — Authors' abstract

03687 **Dixon, Owen A.** Nautiloids and current ripples as paleocurrent indicators in Upper Ordovician limestones, Anticosti Island, Canada: Jour. Sed. Petrology, v. 40, no. 2, p. 682-687, illus., 1970.

Several hundred orthoconic nautiloids on a widely exposed bedding plane in the Ellis Bay Formation show a pronounced apical orientation indicating southwestward paleocurrents. Large separated current ripples on the same bedding plane strike nearly perpendicular to the orthocone azimuth. Tidal currents recurring in an environment of shallow water carbonate sedimentation may explain the sequence of events represented by these strata. — Author's abstract

03138 **Doell, Richard R.** U.S.-Japan Science program: EOS, v. 51, no. 7, p. 551-552, 1970.

Geophysicists and geologists from Japan and the United States met in Honolulu February 2-6, 1970, for the fourth meeting of the paleomagnetism series of the U.S.-Japan Cooperative Science Program. The subjects discussed in the various papers presented are reported. — DBV

03190 **Dogan, Nevzat.** Subsurface study of Pennsylvanian rocks in east central Oklahoma (from the Brown Limestone to the Checkerboard Limestone): Shale Shaker, v. 20, no. 10, p. 192-213, illus., 1970.

The section thickens to the east-southeast from 750 to 2,500 feet. Cross sections and isopach maps suggest that it was deposited on the west-northwest flank of the subsiding McAlester basin. Sands in the section came from structural features around the basin, and they are lenticular, discontinuous, and erratic in thickness. The Cherokee Group was deposited in a series of transgressions and regressions, with the sea advancing farther with each transgression. Sands were deposited during regressive stages. — *from* Author's abstract

03614 **Dolan, Robert.** Dune reddening along the outer banks of North Carolina — Discussion [of "Dune reddening and time" by R. M. Norris, 1969]: Jour. Sed. Petrology, v. 40, no. 2, p. 765, 1970.

For the original paper by Norris, *see* ibid., v. 39, no. 1, p. 7-17, 1969; Abs. of North American Geology, October 1969.

Dolgov, Yu. A. *See* Sobolev, V. S. 03577

03733 **Dorman, LeRoy M.; Lewis, Brian T. R.** Experimental isostasy — [Pt.] 1, Theory of the determination of the Earth's isostatic response to a concentrated load: Jour. Geophys. Research, v. 75, no. 17, p. 3357-3365, illus., 1970.

A method is given for computing the isostatic response function directly from observational data, eliminating the need for assuming a compensation mechanism. If the Earth's response to crustal loading is linear, the response of the gravity field to this loading can be represented as the two-dimensional convolution of the topography with the Earth's isostatic response function. Actually, topography is more likely to be the result of density changes at depth than the cause, but the mathematical treatment

is the same. Through transformation into the frequency domain, the convolution becomes multiplication; the isostatic response function is equal to the inverse transform of the quotient of the transforms of the Bouguer anomaly and topography. The isostatic response function can be inverted to find density changes with depth that result in uplift. — DBV

Dorman, LeRoy M. *See* Lewis, Brian T. R. 03736

Dott, R. H., Jr. *See* Medaris, L. G., Jr. 03416

Douglas, Arthur G. *See* Andersland, Orlando B. 03027

03086 **Douglas, G.; Morency, M.; McDougall, D. J.** Detection of strain in rocks using an intrinsic "semi-insulator" characteristic of some minerals: Modern Geology, v. 1, no. 3, p. 211-217, illus., 1970.

Strain induced by impact or static loading will cause changes in some of the solid-state characteristics of minerals. Although exact relationships have not yet been demonstrated, thermoluminescence provides one means of obtaining a *relative* indication of these changes. Data from investigations of suites of rocks from the vicinity of the Gaspé Copper "A" fault; the Charlevoix, Holleford and Brent "meteorite" craters; and the Sedan nuclear event, are used to illustrate some of the variations of strain-induced thermoluminescence. The results of artificial static loading of high-purity limestone from Bedford, Quebec, and of crushing and grinding of several rock types are also described. An idealized thermoluminescence versus load relationship is suggested as a partial explanation of the changes in "semi-insulator" characteristics due to deformation. — Authors' abstract

03038 **Dozier, Jeff.** Studies of morphology and stream action on ablating ice — Pt. 2, Channel adjustments in supraglacial streams: Arctic Inst. North America Research Paper 57, p. 67-117, illus., tables, 1970.

Two supraglacial streams of Capps Glacier, Wrangell Mts., Alaska, were studied to determine if minimum factor variance in short reaches of ordinary streams also applies to supraglacial streams. Data show that in supraglacial streams, curved reaches have more uniform channel adjustment than do straight reaches; in both curved and straight, these variances are reduced over the course of the summer, and curved reaches are closer to equilibrium than straight. Processes of channel adjustment in supraglacial streams may be divided into: those of the stream itself (thermal erosion in both lateral and downward directions); and those independent of the streams (glacier shearing and movement, and differential ablation of banks above the stream due to differences in exposure). — *from* Author's abstract

Drake, John. *See* Mao, Nai-Hsien. 03730

Dubuc, Fernand. *See* Vallee, Marcel. 03527

03227 **Dudley, John H.** Review of collapsing soils: Am. Soc. Civil Engineers Proc., v. 96, paper 7278, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 925-947, illus., tables, 1970.

Soils which undergo large consolidation when unusual amounts of water are added to them exist in many places around the world. Although surface collapse of 15 feet has occurred, the usual amount is much less. These soils, mainly silt, sand, or gravel, or any of their combinations, are of open structure and exist in nature at less than 100 percent saturation. Water in tension is the general binding material; a small amount of clay is present in many cases, and sometimes other agents. The amount and rate of collapse is a function of grain shape, grain size, moisture content, kinds and amounts of clay present, void ratio, adsorbed ions, etc.; maximum collapse occurs at optimum clay content close to 10 percent and moisture between 13 and 39 percent. Most of the collapse can occur before 100 percent saturation is reached; estimates of possible magnitude are compared to field results. — *from* ASCE abstract

Duennebier, Frederick K. *See* Northrop, John. 03726

DuMontelle, P. B. *See* Swann, D. H. 03059

Dunham, A. C. *See* Dunham, K. C. 03588

03588 **Dunham, K. C.; Dunham, A. C.; Gallagher, M. J.; Solomon, M.; Ford, T. D.** Some aspects of genesis of zinc-lead-barite-fluorite deposits in the Mississippi Valley, U.S.A.—Discussions and contributions [on paper by A. V. Heyl, 1969]: Inst. Mining and Metallurgy Trans, Sec. B, v. 79, Bull. 762, p. B91-B96, illus., 1970.

Heyl's paper was published, ibid., v. 78, Bull. 756, p. B148-B160, 1969; *see* Abstracts of North American Geology, Dec. 1970.

03414 **Dunlop, D. J.** Hematite — Intrinsic and defect ferromagnetism: Science, v. 169, no. 3948, p. 858-860, illus., 1970.

Both intrinsic (spin-canted) ferromagnetism and defect ferromagnetism occur in hematite. Because defect ferromagnetism is sensitive to structure, it is altered by stress or heating and could give spurious paleomagnetic information. Annealing experiments now suggest that the defect remanence of fine-grain hematites and red sediments, unlike that of single crystals, is magnetically softer than the spin-canted remanence and can be erased by partial demagnetization. — Author's abstract

03571 **Dunn, Darrel E.** Ground-water velocity partition: Ground Water, v. 8, no. 4, p. 14, 1970.

The true velocity, V, of ground water at a point in the ground-water system may be expressed as the sum of a number of partial velocities labeled V_1, V_2, V_3, et cetera. Each partial velocity may be defined as a velocity which results from the presence of certain features of the configuration of the water table. Partial velocities may be used to facilitate the discussion of ground-water flow systems and associated phenomena. — Author's abstract

03300 **Dziewonski, Adam M.** Correlation properties of free period partial derivatives and their relation to the resolution of gross earth data: Seismol. Soc. America Bull., v. 60, no. 3, p. 741-768, illus., table, 1970.

A least-square approach to the problem of inversion of a set of observed free oscillation periods leads to a system of normal equations whose solution becomes nonunique if the determinant of the coefficient matrix is or approaches zero. The occurrence of such a condition is investigated by analyzing matrixes of autocorrelation and cross-correlation between the partial derivatives of free oscillation periods. — DBV

03661 **Eby, J. Brian.** Carleton D. Speed, Jr., 1903-1970: Houston Geol. Soc. Bull., v. 12, no. 7, p. 20-21, 1970.

Eckroad, S. W. *See* Aronson, J. R. 03695

Edgar, A. D. *See* Mottana, A. 03710

03225 **Edge, Duane E.; Turnbull, J. MacNeil.** Standardization of particle-size ranges — Discussion [of paper 6795 by Am. Soc. Civil Engineers, Soil Machanics and Found. Div. Comm. Soil Properties, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 1077-1079, 1970.

Paper 6795 (ibid., v. 95, no. SM5, p. 1247-1252, 1969) was cited in Abstracts of North American Geology, April 1970.

Ehlers, Ernest G. *See* Lyon, Stephen R. 03171

03166 **Ehlmann, Arthur J.; Mitchell, Richard S.** Behoite, β-$Be(OH)_2$, from the Rode Ranch pegmatite, Llano County, Texas: Am. Mineralogist, v. 55, nos. 1-2, p. 1-9, illus., tables, 1970.

Behoite, β-$Be(OH)_2$, found in alteration zones around gadolinite in the Rode Ranch pegmatite, Llano County, Tex., generally occurs as euhedral to subhedral colorless crystals of pseudo-octahedral habit up to 1 mm in diameter. Density is 1.92 ± 0.01. It is orthorhombic with an axial ratio of 0.658:1:0.645. Hardness is about 4. Optical, X-ray, DTA, chemical, and infrared data are given. — *from* Authors' abstract

Ehlmann, Arthur J. *See* Gibson, Shirley J. 03178

03550 **Ehmann, W. D.; Rebagay, T. V.** Zirconium and hafnium in meteorites by activation analysis: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 649-658, tables, 1970.

Zirconium and hafnium have been determined in 28 chondrites and 7 achondrites. Their distribution pattern in the three major classes of chondrites shows that the order of atomic abundances for both elements relative to silicon is: carbonaceous chondrites > ordinary chondrites > enstatite chondrites. Average atomic abundances of 13 atoms Zr and 0.19 atom Hf were established for the chondrites. The Ca-rich achondrites were observed to be enriched in these elements relative to chondrites, while an opposite trend was noted for the Ca-poor achondrites. The average Zr/Hf ratio on a weight basis for all the meteorites analyzed was 43. This is in good agreement with that for the Earth's crust and implies no significant fractionation of these elements between the Earth and meteorites. — DBV

Ellis, Robert M. *See* Ishii, Hiroshi. 03351

Elwell, J. H. *See* Simon, D. E. 03659

Emslie, A. G. *See* Aronson, J. R. 03695

Engen, Gladys R. *See* Arabasz, Walter J. 03512

03553 **Eugster, H. P.** The thermal and ionic stability of muscovite [abs.]: Fortschr. Mineralogie, v. 47, no. 1, p. 18-19, 1970.

03554 **Evans, B. W.; Okrusch, M.** Minor element relationships in coexisting andalusite and sillimanite [abs.]: Fortschr. Mineralogie, v. 47, no. 1, p. 20-21, 1970.

Evans, Bernard W. *See* Okrusch, Martin. 03715

03666 **Evans, C. A., Jr.; Guidoboni, R. J.; Leipziger, F. D.** Routine analysis of metals using a spark source mass spectrograph with electrical detection: Appl. Spectroscopy, v. 24, no. 1, p. 85-91, illus., tables, 1970.

An analytical method has been developed using a spark-source mass spectrograph for rapid routine analysis. Using an electrical detection system and reproducible sample positioning, precisions of ± 3 percent are attained under routine conditions with an accuracy of ± 7 percent for several elements in the NBS 460 series of iron standards. Repetitive analyses of Ag in Cu demonstrate the method can analyze trace elements in metals with accuracies approaching ± 2 percent. Details of the electrode positioning procedure, and the analytical accuracy and precision of the technique are presented. — Authors' abstract

03053 **Evans, John W.** A method for measurement of the rate of intertidal erosion [with Spanish abs.]: Bull. Marine Sci., v. 20, no. 2, p. 305-314, illus., 1970.

A method is described for measuring directly the rate of erosion in the intertidal zone. Basically, this method consists of the implantation of permanent bench marks to which can be attached, at intervals, a specially designed drawing table. This table is used to obtain, over a period of years, a series of contour drawings of the rock surface. Precautions are taken to ensure that when subsequent contours are to be drawn in a given location, the table is set up in exactly the same position. The apparatus can be used in any circumstance where the measurement of a gradual erosion or accretion of a hard substrate is desired. — Author's abstract

03612 **Evenson, Edward B.** A method for 3-dimensional microfabric analysis of tills obtained from exposures or cores: Jour. Sed. Petrology, v. 40, no. 2, p. 762-764, illus., 1970.

Apparent bearing and plunge of sand-sized particles can be determined in oriented thin sections prepared from epoxy-impregnated till samples. Impregnation is achieved, with no noticeable reorientation, with the aid of a vacuum. Two mutually perpendicular thin sections are prepared. One section is horizontal and is used to determine the modal long axis bearing of the sample. The second section, used to determine plunge, is vertical and cut parallel to the modal lineation of the horizontal section. Excellent agreement has been found between bearing and plunge values obtained using this technique and values obtained using conventional microfabric techniques. — Author's abstract

03579 **Evernden, J. F.** Study of regional seismicity and associated problems: Seismol. Soc. America Bull., v. 60, no. 2, p. 393-446, illus., 1970.

This paper constitutes a compilation of seismicity data available in the literature plus regional and worldwide data obtained from the USCGS Preliminary Determination of Epicenter (PDE) lists. Data are presented in the form of the recurrence relationship of log N versus magnitude, where N is either cumulative or incremental number of earthquakes, and magnitude is either m_b or M_S. Relative shapes of these recurrence curves as regards m_b versus M_S, large magnitude versus small magnitude, shallow focus versus deep focus, etc. are discussed. Conclusions on variability of seismicity with time and on worldwide level of seismic activity are included. — Author's abstract

Ewing, J. I. *See* Markl, R. G. 03637

03039 **Ewing, Karen.** Studies of morphology and stream action on ablating ice — Pt. 3, Supraglacial streams on the Kaskawulsh Glacier, Yukon Territory: Arctic Inst. North America Research Paper 57, p. 119-167, illus., 1970.

Two general categories of supraglacial stream channels were identified during 1965 and 1966 on the Kaskawulsh Glacier, Yukon Territory. *Annual* streams have shallow channels and are recreated each year. *Perennial* streams have deeper channels which are reused from year to year and show an elongation of stream patterns which closely parallel the ice flow pattern of the glacier. All streams show diurnal fluctuations of discharge, related to high and low sun periods. Static factors influencing supraglacial stream development and morphology include relief, gradient, and biota. Dynamic processes include glacier flow and climate. — Author's abstract

03326 **Fabbi, Brent P.; Moore, William J.** Rapid X-ray fluorescence determination of sulfur in mineralized rocks from the Bingham mining district, Utah: Appl. Spectroscopy, v. 24, no. 4, p. 426-428, table, 1970.

Determination of total sulfur by X-ray fluorescence eliminates problems of incomplete oxidation of sulfur or coprecipitation often encountered in gravimetric analyses. Durable pellets are prepared from finely ground sample powders mixed with chromatographic cellulose. X-ray fluorescence total sulfur values compare well with gravimetric sulfur values. — Authors' abstract

03168 **Fanfani, L.; Nunzi, A.; Zanazzi, P. F.** The crystal structure of roemerite: Am. Mineralogist, v. 55, nos. 1-2, p. 78-89, illus., tables, 1970.

Crystallographic, chemical, and thermic data are given for roemerite from Dexter Mine, Utah. The structure consists of isolated $Fe(H_2O)_6$ and $Fe(H_2O)_4(OSO_3)_2$ groups. These groups are weakly connected with one another by a system of hydrogen bonds. The Fe ions are surrounded octahedrally by oxygen atoms. The ferrous iron coordinates with six water molecules. The ferric iron binds four water molecules and two oxygen atoms belonging to different SO_4 groups. The sulfate groups show the normal tetrahedral form. — *from* Authors' abstract

03644 **Federer, B.; vonSury, H.; Philberth, K.; deQuervain, M.** Outflow and accumulation of ice in Jarl-Joset Station, Greenland: Jour. Geophys. Research, v. 75, no. 24, p. 4567-4569, table, 1970.

With the help of the geodetic surveys of the EGIG (International Glaciological Greenland Expedition) profile in 1959 and 1968 and the absolute measurements of the deformations of the inclined shaft 'Dumont,' the vertical velocity of the ice at Jarl-Joset station, Greenland, is determined. This velocity is shown to be independent of short-time variations of the accumulation rate and is therefore characteristic for the long-term movement of the ice sheet. By comparison of this velocity with the short-time accumulation, it is shown that the mass budget in the last ten years is negative (about 20 percent), which explains the lowering of the surface measured by the survey. — Authors' abstract

03284 **Fenner, Peter; Lloyd, Joel.** Serials important to geologists: Geotimes, v. 15, no. 6, p. 14-17, tables, 1970.

Scientific literature is divided into four classes: pre-primary, accessible to an in-group of specialists, often never formally published; primary, in which appear the first formal results of investigations, etc.; secondary, including indexes, and abstract and review journals; and tertiary, including texts and reference books, handbooks, etc. There are about 15,000 titles of serials that present some 40,000 geologic papers annually. Two tables list 94 serials that make up 49 percent of the geologic literature cited in the 1969 Bibliography of Geology. In the second table they are listed in decreasing rank order according to the number of papers indexed. — ESL

03104 **Fenton, Michael Dwight.** The evolution of the isotope composition of terrestrial strontium [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4660B-4661B, 1970.

Ferm, John C. *See* Flores, Romeo M. 03597

03389 **Field, Michael; Pilkey, Orrin H.** Lithification of deep sea sediments by pyrite: Nature, v. 226, no. 5248, p. 836-837, illus., 1970.

Unique pyrite-cemented silty sand layers have been found in three piston cores taken from the North Carolina lower continental rise at depths of 4,770-4,950 m. None of the precursor iron sulfides usually associated with sedimentary pyrite were found. The unusual combination of typically organic-rich continental margin sediments deposited in rapid pulses but accumulating at overall rates slower than usual may be the important causative factor for extensive pyritization in the uppermost portions of the sediment column. The pyritized layers must play a part in restricting and channeling vertical exchange between sea water and sediment as well as in interstitial water reactions and migration. The occurrence is of great interest as the second known mechanism of lithification in the uppermost portions of deep-sea sediments, the first being calcium carbonate. — DBV

03306 **Filson, John.** S velocities at near distances in western central California: Seismol. Soc. America Bull., v. 60, no. 3, p. 901-915, illus., tables, 1970.

The average velocity of a single direct S arrival at Berkeley (BRK) from 25 earthquakes within 108 km is 3.60 ± .05 kmps. At Vineyard (VIN) the clearest arrival from 12 earthquakes within 97 km has a velocity of 3.00 ± .06 kmps, while a weaker, earlier arrival for Δ = 50-100 km indicates a velocity of 3.51 ± .06 kmps; these two arrivals may be due to either a lateral or vertical crustal velocity contrast. The greater attenuation of the higher velocity arrival at VIN with respect to BRK may indicate the dimension of an anelastic zone associated with regional faulting. SH arrivals have been identified as SH_n with a velocity of 4.5 ± 2 kmps. Source motions inferred from S-particle motion at BRK show a strong orientation with the trend of the regional faulting. — *from* Author's abstract

03139 **Fisher, David E.** Homogenized fission track analysis of uranium in some ultramafic rocks of known potassium content: Geochim. et Cosmochim. Acta, v. 34, no. 5, p. 630-634, illus., table, 1970.

New data on the U contents of a diverse suite of ultramafic rocks are presented. The K/U ratio is equal to or less than the crustal ratio, in disagreement with the concept of a chondritic Earth. — Author's abstract

03442 **Fisk, H. G.** Painted Rocks Lake area, southern Ravalli County, Montana: Montana Bur. Mines and Geology Spec. Pub. 47, 1 sheet, scale about 1 in. to 2/3 mi., text [1970?].

In most of the southern part of the Painted Rocks Lake area, Precambrian Ravalli Quartzite and related rocks crop out, in places covered by irregular fingers of Cretaceous and Tertiary volcanic rocks. The northern section is part of the Idaho batholith with Cretaceous and Tertiary plutons, intrusives, and volcanic rocks. Although faults or other structural features were not mapped, drainage patterns of several streams are believed to be fault controlled. Of possible economic interest are placer gold, tungsten, copper, and fluorspar. — MCM

Fitch, Thomas J. *See* Scholz, C. H. 03559

03499 **Fleet, M. E.** Structural aspects of the marcasite-pyrite transformation: Canadian Mineralogist, v. 10, pt. 2, p. 225-231, illus., table, 1970.

Oriented single crystals of marcasite have been inverted to pyrite by heating under vacuum in the temperature range 425 to 475°C. X-ray diffraction studies reveal two preferred orientations of pyrite, with a_2 of pyrite parallel to b of marcasite and a_1 and a_3 sub-parallel to [101] of marcasite, agreeing with the orientation of some natural intergrowths of the two minerals. It is suggested that the inversion occurs by rotation of the Fe-S chains in alternate layers of the {101} planes of marcasite. The shape of the X-ray reflections recorded in the plane normal to the common b axis suggests that the crystallites have been rotated about this axis: the nature and extent of the movement and the displacement between the two pyrite orientations within this plane tend to agree with the proposed transformation model. — Author's abstract

Fleischer, Robert L. *See* Ahrens, Thomas J. 03363

03597 **Flores, Romeo M.; Ferm, John C.** A recent model for Pennsylvanian deposition in the Marathon basin, west Texas: Jour. Sed. Petrology, v. 40, no. 2, p. 621-628, illus., 1970.

The Haymond Formation comprising the Middle Pennsylvanian strata of the Marathon basin of west Texas consists of a series of interbedded sandstones, siltstones, shales, and boulder beds which have been interpreted as deep water turbidites deposited in a trench-like area surrounded by tectonically active highlands. Detailed studies of this sequence, in conjunction with investigations in the south shore of Lake Erie in western New York, suggest an alternative explanation in which the Haymond is interpreted as a prograding deltaic unit formed from short-headed and steep gradient streams in a nearby but not necessarily high source area. Proximity of the source provides an explanation for the turbidite-like character of the delta front portion of the sequence as well as for the presence of boulder beds in the delta plain deposits. — Author's abstract

03485 **Folinsbee, R. E.** Rb/Sr, S, and O isotopic analyses indicating source and date of contact metasomatic copper deposits, Craigmont, British Columbia, Canada — A reply [to 1970 discussion by L. Chrismas and others of 1969 paper]: Econ. Geology, v. 65, no. 1, p. 63-64, 1970.

For original paper, *see* ibid., v. 64, no. 5, p. 479-488, 1969; Abs. North American Geology, April 1970.

Folk, Robert L. *See* Ward, William C. 03682

03410 **Folsom, Michael M.** The glacial geomorphology of the Puget Lowland, Washington and British Columbia, comments and selected references: Northwest Sci., v. 44, no. 2, p. 143-146, 1970.

The glacial geomorphology of the Puget Lowland has escaped detailed consideration in the literature of general Pleistocene events. With the hope of increasing interest in this regional topic, this list of selected references is offered. It is limited to those works dealing with Pleistocene glacial events and processes, excluding items concerning Holocene or more strictly glaciological topics. Comments, additions or suggested deletions are solicited. — GDC

Ford, T. D. *See* Dunham, K. C. 03588

03372 **Ford, Trevor D.; Breed, William J.** Carbon Butte, an unusual landslide in the Grand Canyon: Plateau, v. 43, no. 1, p. 9-15, illus., 1970.

The stratigraphy and structure of Carbon Butte, a landslide block in the Grand Canyon, are described. This block was formed by a mass of Paleozoic strata which has slid with some backward rotation under gravity to rest in a syncline of the younger Precambrian Chuar rocks. The difference in elevation between Carbon Butte and the cliff from which it was derived shows that the block has slid about one mile and dropped 1800 feet; in the process, all of the Tapeats Sandstone at the base of the block was left behind as a slope of detached boulders. — Authors' abstract

03125 **Forsyth, Jane L.** A geologist looks at the natural vegetation map of Ohio: Ohio Jour. Sci., v. 70, no. 3, p. 180-191, illus., table, 1970.

Boundaries on the new map of the *Natural vegetation of Ohio* by Gordon (1966) neatly follow, in most places, geologic boundaries. Where this is not true, conditions controlling this distribution are either aspect, microclimate, or the result of some as-yet unrecognized variation in the geology. Beech (-maple) forests occur on better drained Wisconsin till and in outwash-free valleys; oak-sugar maple forests occur where the substrate is moist enough for sugar maple but not beech; mixed mesophytic forests occur on shale and on north-facing slopes in unglaciated eastern Ohio and in other complex-geologic areas; mixed oak forests are "dry" species occurring on south-facing slopes and sandstone hills or on well-drained gravel deposits, and "wet" species are on flat plains in heavy clay soils; swamp forests are also present, as are prairies. — *from* Author's abstract

03566 **Forward, Frank Arthur.** Science in the mineral industry, a look ahead: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 181-184, 1970.

This paper reviews the major periods of scientific advance in recent history, and applies them to the modern context. The most demanding areas are outlined, as far as the mineral industry is concerned, and a future course of action is suggested. — Author's abstract

03655 **Foster, John D.; Palmquist, Robert C.** Possible subglacial origin for "minor moraine" topography: Iowa Acad. Sci. Proc. 1969, v. 76, p. 296-310, illus., tables, 1970.

Surface expression of Cary age drift exhibits a pattern of intersecting linear ridges and depressions, known as swell-swale or minor moraine topography. Ridges are aligned either parallel or transverse (45° to 90°) to associated end moraine systems. Both types of ridges appear genetically related, range in height from 5-20 feet, and are composed of till. The irregular shape and high dip of crossbedding of small sand bodies, and the dip of small faults and joints suggest a controlled ice-disintegration origin. Alignment of till fabric with glacier flow is indicative of lodgment till or ground moraine. The hypothesis that these represent annual recessional moraines does not explain lack of outwash, origin of transverse ridges, till fabric, number of moraines, and their geographic distribution. Alternate hypotheses are: crevasse fill, ice marginal thrust, basal crevasse squeeze, and boundary wave phenomena. — *from* Authors' abstract

03729 **Foster, John H.; Opdyke, Neil D.** Upper Miocene to recent magnetic stratigraphy in deep-sea sediments: Jour. Geophys. Research, v. 75, no. 23, p. 4465-4473, illus., 1970.

Two long piston cores of deep-sea sediment, 26 and 28 m in length, taken in the equatorial Pacific on the 12th cruise of the *Robert D. Conrad*, penetrate calcareous and siliceous ooze to sediments of Miocene age. Paleomagnetic measurements were made on samples partially demagnetized in a 60-Hz alternating field of 50 oe; sampling interval was every 10 cm between reversals and continuously across reversal boundaries. Similar measurements were made at 10-cm intervals on a siliceous ooze core 15 m in length and on a red lutite core 8 m in length. All cores show magnetic stratigraphy extending below the Gilbert polarity series/epoch 5 boundary. One long core has continuous magnetic record back to an epoch we correlate with sea-floor spreading anomaly 5 at 9 m.y. or older. This record has been subdivided into seven new magnetic epochs numbered from epoch 5 to epoch 11. The stratigraphy observed is in agreement with magnetic polarity epochs predicted by sea-floor spreading. — *from* Authors' abstract

Frederick, Bernard J. *See* Godfrey, Richard G. 03210

Freeman, Val L. *See* Kiilsgaard, Thor H. 03207

03297 **Friedlaender, C. G. I.** Tridymite in the gangue of a Pb-Cu-Zn occurrence [with French abs.]: Schweizer. Mineralog. u. Petrog. Mitt., v. 50, no. 1, p. 183-199, illus., 1970.

Tridymite ascertained in the gangue of the Pb-Cu-Zn occurrence of Dunbrack Prospect, Musquodoboit River, Nova Scotia, has been studied with U-stage methods. An additional division in alternating sectors of six-sided trillings is formed by a distinct crystalline phase, with $2V_z$ about 30°, while the main part of the composite tridymite crystals has an axial angle $2V_z$ about 17°. Different types of interposition lamellae of tridymite in quartz have been observed. — Author's abstract

03298 **Friedlaender, C. G. I.** Brownian movement in quartz, an attempt at quantitative evaluation [with French abs.]: Schweizer. Mineralog. u. Petrog. Mitt., v. 50, no. 1, p. 13-20, illus., 1970.

Evaluation of a movie film of the movement of a gas bubble in a liquid inclusion in quartz from Dunbrack Prospect, Musquodoboit River, Halifax County, Nova Scotia, resulted in the tentative determination of the viscosity of the liquid. — Author's abstract

Friedman, Gerald M. *See* Schroeder, Johannes H. 03602

03347 **Friedman, Irving; Smith, George I.** Deuterium content of snow cores from Sierra Nevada area: Science, v. 169, no. 3944, p. 467-470, illus., table, 1970.

The relative deuterium content was measured on 37 snow cores collected in April 1969 in the Sierra Nevada. The deuterium content varies inversely with altitude of collection (approximately 40 per mil per 1,000 meters) but is unrelated to latitude. The altitude relationship is particularly well defined west of the crest of the range but is not well defined east of the crest. However, samples from east of the crest tend to be depleted by about 10 to 15 per mil relative to samples collected at the same elevation west of the crest. We propose that the deuterium content of snow cores, collected so as to include the total winter's precipitation, can be used as a climatic indicator to compare the climate of one winter with that of another. — Authors' abstract

Fripiat, J. J. *See* Fuls, P. F. 03122

03255 **Fritsche, Albert Eugene.** Miocene geology of the central Sierra Madre Mountains, Santa Barbara County, California [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5099B, 1970.

Frohlich, H. *See* McNary, J. F. 03708

03256 **Fullam, Timothy Jewell.** The measurement of bedload from sandwave migration in Bonneville Reservoir on the Columbia River [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5099B, 1970.

03122 **Fuls, P. F.; Rodrique, L.; Fripiat, J. J.** Iron alkoxide obtained by reacting iron oxides with glycerol [with French, German and Russian abs.]: Clays and Clay Minerals, v. 18, no. 1, p. 53-62, illus., tables, 1970.

Goethite, lepidocrocite, and hematite were reacted with glycerol and reaction products studied at various steps. After 16 hours at 245°C, the final form, a deep-green soft solid identified as iron alkoxide, was obtained. Hydrolysis yielded glycerol and a magnetic substance with a spinel structure. Electron microscopy showed large well-formed hexagonal platelets. The *a* and *b* parameters are similar to those of brucite suggesting that the structure is based on an iron (II and III) octahedral layer. Glycerol chains should be located between the sheets. Two models are proposed in which iron and oxygen, linked to the chain of glycerol, could be accommodated in octahedral layers giving a basal distance of 8.1 A. At least two steps are involved in the formation of iron alkoxide, a rearrangement of the structure of the starting material to accommodate carbon, and a reduction of ferric iron. — *from* Authors' abstract

Furnish, W. M. *See* Spinosa, Claude. 03539

Furumoto, A. S. *See* Weaver, P. F. 03158

Furumoto, A. S. *See* Woodcock, A. H. 03162

Fuson, Michael L. *See* Conkin, James E. 03536

03279 **Fyles, James T.** Structure of the Shuswap metamorphic complex in the Jordan River area, northwest of Revelstoke, British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 87-98, illus., table, geol. map, 1970.

The paper describes the structure of high-grade metamorphic rocks on the southeastern flank of the Frenchman's Cap gneiss dome in the Monashee Mountains near Revelstoke, British Columbia. Rocks extend upward from gneisses which form the core of the dome into metasedimentary schists and gneisses which envelope the dome. Nepheline syenite gneiss forms concordant masses in the sequence and porphyritic granite gneisses form later discordant intrusions. Deformation is intense and repetitive. Phase 1 folds are recumbent and somewhat isoclinal, with axes trending southwest in the western part of the area, and east in the eastern part. Axial planes have a low regional dip to the south, but are tightly folded by Phase 2 structures whose axial planes dip south. Phase 3 folds are south-plunging structures that cause southeastern curvature of the layers forming the dome. — *from* Author's abstract

03015 **Fyson, W. K.** Structural relations in metamorphic rocks, Shuswap Lake area, British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 107-122, illus., tables, 1970.

Rocks of the Shuswap Lake area vary from amphibole-garnet schist and gneiss with sillimanite in the east to low-grade argillite. Four phases of progressive deformation and accompanying metamorphism affected most of the rocks. Attenuated F_1 isoclines with axial-surface schistosity prominent in the lower rocks are absent in argillite. F_2 recumbent folds in the schistosity trend constantly in some areas, but in others veer abruptly. In the eastern gneiss, easterly-trending F_2 folds verge southward for over 25 miles, and cross folds verge westward down-dip toward phyllites. Discontinuous upright folds belong to subphases of F_2 and F_4. Early F_3 are commonly coaxial with F_2, later F_3 trend northwestward, and F_4 northward. In the south, phyllites with steep foliation are tightly folded by large F_3, but most underlying schists and gneisses affected by F_3 have few F_3 structures larger than crinkles and mineral lineations. — *from* Author's abstract

Gallagher, M. J. *See* Dunham, K. C. 03588

03232 **Gangloff, Pierre.** Structures de gélisols reliques dans la région de Montréal [Structures of relict gelisols in the Montreal region (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 241-253, illus., table, 1970.

Fossil ice wedges examined on the foreside of and inside the Adrien-Robert moraines (formerly St. Faustin-St. Narcisse moraines) may date back to Dryas III times. The wedge, studied north of the morainic belt in the Laurentians, was formed during postglacial times and may date back to the Boreal (Cockburn stage) marked by a lowering of temperature. The increased coldness was not enough to have produced continuous permafrost; rather, the scarcity of wedge-type structures seems to indicate discontinuous permafrost conditions. On Lake Champlain near Montreal, on terraces from 45 to 122 m in elevation, there are numerous cryoturbation features limited to frost-sensitive sediments. Some wedges date back to the Dryas III, others are postglacial and may be linked with the Cockburn stage, corroborating indications of a cold spell in Boreal times, when seasonal frost activity affected soils to 3 m depths. Patches of permafrost may have existed in the lowland. — *from* Author's abstract

03081 **Gardner, J.** Rockfall, a geomorphic process in high mountain terrain: Albertan Geographer, no. 6, p. 15-20, tables, 1970.

This paper presents data gathered from 1965 to 1967 in the Lake Louise area of the Canadian Rocky Mountains, an area of high, glacierized mountains with "step and bench"-type slopes with angles from 5° to 60°, averaging 25° to 31°. Based on an inventory of characteristics of the rockfalls, tables show frequency per hour and day, spatial distribution, and magnitude and frequency relationships. Rockfalls occur frequently but with random temporal seasonal distribution, with maximums in the early morning and during mid-day. They occur most often on the high, mountain walls, facing north to east, in areas of steep terrane. Magnitude is related to decrease in frequency; the least frequent events result in the greatest volume of material moved. Debris slopes, with a downslope sorting of surficial material, and protalus ramparts may result partly from rockfall activity. — EH

Garner, L. E. *See* McGowen, J. H. 03136

03080 **Gartner, Stefan, Jr.** Sea-floor spreading, carbonate dissolution level, and the nature of horizon A: Science, v. 169, no. 3950, p. 1077-1079, illus., 1970.

Evidence from leg 2 of the Deep Sea Drilling Project suggests a constant spreading rate for the floor of the North Atlantic over the past 80 million years; a major lowering of the carbonate dissolution level during the early Pliocene; and an early to middle Eocene age for horizon A. — Author's abstract

03257 **Garvin, Paul Lawrence.** Phase relations in the Pb-Sb-S system [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5100B, 1970.

Gauger, J. *See* Slade, D. V. 03088

Gee, Dennis M. *See* Wiegel, Robert L. 03719

03079 **Gentry, Robert V.** Giant radioactive halos, indicators of unknown radioactivity?: Science, v. 169, no. 3946, p. 670-673, illus., table, 1970.

A new group of giant radioactive halos has been found with radii in excess of anything previously discovered. Since alternate explanations for these giant halos are inconclusive at present, the possibility is considered that they originate with unknown alpha radioactivity, either from isomers of known elements or from superheavy elements. — Author's abstract

03716 **Gessler, Johannes.** Self-stabilizing tendencies of alluvial channels: Am. Soc. Civil Engineers Proc., v. 96, paper 7263, Jour. Waterways and Harbors Div., no. WW 2, p. 235-249, illus., table, 1970.

Channels constructed in coarse alluvial material tend to develop an armor coat at the bed's surface protecting the material beneath the top layer from further erosion. A method is outlined which permits the prediction of the grain-size distribution curve of such a self-stabilized armor coat as well as of the eroded material. Based on these results, it is possible to make an estimate on the minimum amount of material to be eroded prior to development of a stable condition resulting from armoring. An at-

tempt is made to determine those conditions which result in a finally stable bed. This leads to a design criterion for stable channels constructed in coarse nonuniform alluvial material. This design criterion integrates the stabilizing influence of all grain sizes present in a self-stabilized armor coat and permits operating the channel at a preset factor of safety. — ASCE abstract

03482 **Ghosh-Dastidar, P.** Syntheses of sulfide standards for quantitative spectrochemical analyses: Econ. Geology, v. 65, no. 1, p. 56-59, illus., tables, 1970.

For spectrochemical work, synthetic standards of pyrite, pyrrhotite, chalcopyrite, and sphalerite were prepared. These were mixed with various amounts of eighteen different trace elements to yield working curves that take the matrix effect of each mineral into account. In general, matrix effects for these particular sulfides were found to be small. — WSW

Gibson, Gary C. *See* Coyle, Harry M. 03228

03178 **Gibson, Shirley J.; Ehlmann, Arthur J.** Annealing characteristics of metamict gadolinite from Rode Ranch, Texas: Am. Mineralogist, v. 55, nos. 1-2, p. 288-291, illus., table, 1970.

Chemically analyzed metamict gadolinite was heated in air at varied temperatures and time intervals. At 1080°C gadolinite was well crystallized by 1 hour. At 880°C samples showed a lesser but constant level of crystallinity. At 780°C and 730° the gamma phase reported at 1300° by Lima-de-Faria (1964) was predominant, but it remained poorly developed after heating for several days. At 680° no recrystallization was detected after one week heating. DTA showed a large exotherm at 810° and smaller exotherms at 850° and 900°. The degree of recrystallization, determined by three X-ray diffractogram peak areas, was influenced more by temperature than by heating time. — Authors' abstract

03753 **Gibson, T. G.** Late Mesozoic-Cenozoic tectonic aspects of the Atlantic coastal margin: Geol. Soc. America Bull., v. 81, no. 6, p. 1813-1822, illus., table, 1970.

Data from middle northern Atlantic Coastal Plain and continental slope show filling of Atlantic margin geosyncline occurred in pre-latest Cretaceous time with thin additions of Cenozoic strata. Influx of detrital material into offshore areas had ceased by latest Cretaceous time, was absent in early Cenozoic, but increased in Miocene, indicating rejuvenation of Appalachian source. Basin migration continued throughout Cenozoic, and Miocene and Eocene strata illustrate shifting of loci of disposition. Distributions of strata indicate that local to regional tectonic movements are responsible. Comparison with Gulf Coast geosyncline shows that though features such as thickness, evaporates, and volcanic materials are similar between the two margins, differences in time of filling and regional tectonic movements exist. — *from* Author's abstract

Gilbert, C. M. *See* Christensen, M. N. 03677

03095 **Gill, Ajit Singh.** A study of cohesion in terms of effective stresses for some Ontario clays [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4607B, 1970.

Gill, Angela C. *See* McHenry, J. Roger. 03523

Gillon, Allon. *See* Ben-Menahem, Ari. 03069

03435 **Gittins, J.; Hayatsu, A.; York, D.** A strontium isotope study of metamorphosed limestones: Lithos, v. 3, no. 1, p. 51-58, tables, 1970.

Sr-87/Sr-86 ratios are presented for calcites extracted from metamorphosed Grenville marbles. These range from 0.7021 to 0.7090, and thus cover a spread of values representative of both sedimentary limestones and carbonatites. It appears that sedimentary limestones have a much wider spread of Sr-87/Sr-86 values than is

generally assumed or that the ratios undergo considerable adjustment during extensive metamorphism. In either case it does not appear possible to distinguish carbonatite from sedimentary limestone on the basis of strontium isotope studies alone. — Authors' abstract

Glenister, Brian F. *See* Spinosa, Claude. 03539

03189 **Globensky, Yvon.** The nature of conodonts [with French abs.]: Naturaliste Canadien, v. 97, no. 2, p. 213-228, 1970.

Literature on the taxonomic position and anatomical function of conodonts is reviewed (54 references, 1856-1969). Theories are summarized under the phyla to which the conodont animals have been tentatively referred: Chordata (primitive "fishes"), Annelida and other worms, Mollusca, Arthropoda, and unknown. Arguments against the theories are summarized under the headings: radular teeth of gastropods; crustaceans; copulating structures in flatworms and roundworms; Annelida (scolecodonts); teeth of ingestive organs, skin scales, gill arches (of chordates); internal supporting elements (of unknown animal). Globensky gives his reasons for favoring the interpretation, first suggested by Hass (1941), of conodonts as internal supports for tissues in some soft-bodied marine animal, but whose affinities remain unknown. — VMJ

03210 **Godfrey, Richard G.; Frederick, Bernard J.** Stream dispersion at selected sites: U.S. Geol. Survey Prof. Paper 433-K, p. K1-K38, illus., tables, 1970.

Eleven tests were conducted to study the dispersion patterns of a radiotracer in five natural stream channels and in one canal. The radiotracer, gold-198, was injected as a line source. The patterns of dispersion that were observed in these channels were compared with patterns predicted by the theoretical model for one-dimensional flow developed by G. I. Taylor (1954). Analysis of the relation between time and concentration of the tracer at several sections in each of the six reaches shows that this theoretical model is not adequate to describe the dispersion patterns actually observed. Dispersion coefficients determined from the test data, though constant as theoretically predicted, are about four to 35 times greater than those predicted by Taylor. — Authors' abstract

03758 **Gomberg, David N.; Bonatti, Enrico.** High-magnesian calcite — Leaching of magnesium in the deep sea: Science, v. 168, no. 3938, p. 1451-1453, illus., table, 1970.

The high-magnesian calcite fraction of a shallow-water carbonate sand was converted to low-magnesian calcite after transport to the deep sea; strontium was also leached from the carbonate. Oxygen isotopic ratios indicate that loss of magnesium and strontium took place during recrystallization of the carbonate in the deep sea; this process did not alter textures of skeletal fragments. Previously, high-magnesian calcite was thought only to dissolve in the deep sea. — Authors' abstract

03036 **Goode, Harry D.** Landslides as geologic hazards in Utah, *in* Governor's conference on geologic hazards in Utah, December 14, 1967: Utah Geol. and Mineralog. Survey Spec. Studies 32, p. 21, illus., 1970.

Utah's ancient landslide areas are concentrated on slopes in the Uinta Mountains along the Wasatch Range, and in the central and southern plateau areas; active areas are listed. Areas that have slid in the past may slide in the future. Some potential landslide areas can be recognized by their typically rough uneven topography with reverse slopes, bordered on the upslope side by a steep scarp; other potential areas can be detected only by extensive tests. All land considered for construction sites should be tested for stability, and land that fails the tests should be avoided or stabilized. — MCM

03696 **Gopalan, K.; Wetherill, G. W.** Rubidium-strontium studies on enstatite chondrites — Whole meteorite and mineral isochrons: Jour. Geophys. Research, v. 75, no. 17, p. 3457-3467, illus., tables, 1970.

Eight enstatite chondrite falls have been analyzed for K, Rb, and Sr concentrations and Sr isotopic composition. Density fractions from Indarch ($< 37\ \mu$) were analyzed for Rb-Sr. The total samples show Sr-86/Sr-87 ranging from 0.7200 to 1.001 and the density fractions from 0.7600 to 1.015. All the total samples lie on a straight line, giving an age of 4.54 ± 0.13 b.y., and initial Sr-87/Sr-86 ratio of 0.6993 ± 0.0015. The concentrates also lie on an isochron corresponding to an age of 4.56 ± 0.15 b.y., and initial Sr-87/Sr-86 ratio of 0.7005 ± 0.0030. Total samples show K/Rb ratios of 250 to 900; density fractions show a more uniform ratio of about 250. The mean Sr content is about 30 percent less than that of ordinary chondrites. — DBV

03309 **Gordon, David W.; Bennett, Theron J.; Herrmann, Robert B.; Rogers, Albert M.** The south-central Illinois earthquake of November 9, 1968 — Macroseismic studies: Seismol. Soc. America Bull., v. 60, no. 3, p. 953-971, illus., tables, 1970.

The November 9, 1968 earthquake in south-central Illinois occurred in the New Madrid zone, a seismic zone associated with northeast-trending geological structure. Landforms in the epicentral area consist of nearly flat, glacial lake plains surrounding low, loess-covered hills. An extensive post office canvass and a field inspection of the epicentral area indicates that the strongest shaking (MM VII) took place in the Wabash and Ohio Valleys and adjacent lowlands of south-central Illinois. Characteristic damage included broken chimneys, fallen plaster, and occasional instances of collapsed parapets and overthrown tombstones. Observed rotations of tombstones and other objects in the epicentral area suggest a quadrant distribution of clockwise and counter-clockwise rotations. — Authors' abstract

03530 **Gorsline, D. S.** Submarine canyons, an introduction: Marine Geology, v. 8, nos. 3-4, p. 183-186, 1970.

In this special issue on submarine canyons, it is pointed out that many of the explanations offered for the origin of these canyons, prior to the development of sophisticated equipment which appeared after World War II, cannot explain the canyons as they are now known. At present it is generally agreed that marine processes are responsible. We can be reasonably certain that much of the terrigenous sediment that reaches the deep-sea floors adjacent to continents (and probably all the sand that reaches deep-water depositional sites) passes through the canyons. Submarine canyons and fans at their mouths are invariably associated during the canyons' period of activity. A merger of marine geologists and stratigraphers is predicted. — HRC

Gott, Garland. *See* Kleinkopf, M. Dean. 03472

03369 **Gould, Stephen Jay.** Evolutionary paleontology and the science of form: Earth-Sci. Rev., v. 6, no. 2, p. 77-119, illus., table, 1970.

A science of form, now being forged within evolutionary theory, studies adaption by quantitative methods, using the organism-machine analogy as a guide; it seeks to reduce complex form to fewer generating factors and causal influences. If a function can be postulated for a structure, then its optimum form, or paradigm, can be specified on mechanical grounds. We can simplify the generation of apparent complexity by recognizing that physical forces directly influence shape and that a few simple rules can fashion some very intricate products, and these rules can be programmed. Univariate techniques display trends and rates of change for single characters. Bivariate procedures have been plagued by errors of method but can, when properly applied, separate species and sexual dimorphs. Multivariate methods in the R and Q modes are also available. — *from* Author's summary

03665 **Govindaraju, K.** Use of complexing agents as solvents for atomic absorption determination of calcium and magnesium in silicates: Appl. Spectroscopy, v. 24, no. 1, p. 81-85, illus., tables, 1970.

A rapid atomic absorption method, using an air-acetylene flame, for the determination of calcium and magnesium is described. The sample is fused with a mixture of lithium and strontium borate, and the ground fusion product is dissolved in dilute

citric acid. Strontium and citric acid present in solution act as protecting agents, and the interfering effect of the major constituents of silicate samples is thus eliminated. The use of organic acids (citric acid, EDTA) as solvents instead of inorganic acids (HCl, HNO_3) has the advantage of increasing the absorption values of calcium and magnesium. The results of the analysis of several geochemical rock standards show good accuracy and reproducibility. — Author's abstract

03648 **Graber, F. M.; Lukens, H. R.; MacKenzie, J. K.** Neutron activation analysis determination of all 14 stable rare-earth elements with group separation and Ge(Li) spectrometry: Jour. Radioanal. Chemistry, v. 4, no. 2, p. 229-239, illus., tables, 1970.

A lithium-drifted germanium detector, 40 cm^3, combined with a radiochemical group separation, has been utilized to determine the concentrations of 14 stable rare-earth elements in a silicate rock sample, following thermal-neutron activation. Thirteen rare earths could be determined within an 8-day decay period. The remaining rare-earth element (Tm) required a longer delay, and subtraction of the interfering contribution from Tb-160. Samples of standard rock G-1 and W-1 were also analyzed by this procedure for 13 rare-earth elements, results of which are compared with literature values. — Authors' abstract

03449 **Grachev, A. F.; Demenitskaya, R. M.; Karasik, A. M.** Dissimetriya — General'naya cherta tektonicheskogo razvitiya Arktiki (Dissymetry — A general feature of tectonic development of the Arctic): Akad. Nauk SSSR Doklady, v. 192, no. 4, p. 860-861, illus., 1970.

Based on recent geologic, geophysical and bathymetric data, the dissymetry of the Arctic has been recognized. The relatively stable western part includes Canada, Greenland, Northern Europe and the western part of Siberia. The Precambrian crystalline basement appears at the surface, sedimentary deposits are thin and shelves narrow. Continental platforms have been characteristic since late Proterozoic times and uplift movement has predominated. In the eastern part, consisting of eastern Siberia, Chukotka and Alaska, the basement is deeply buried, sediments are thick and shelves wide. From early Paleozoic to present times geosynclinal development and subsidence have predominated. Present dissymetry in the Arctic reflects dissymetry of a higher order as shown by the existence of the Atlantic and Pacific segments of the Earth. — EH

Grant, James. *See* Parham, Walter. 03490

Gray, Jerry J. *See* Kingston, Gary A. 03208

03629 **Gray, Richard E.; Meyers, James F.** Mine subsidence and support methods in Pittsburgh area: Am. Soc. Civil Engineers Proc., v. 96, paper 7407, Jour. Soil Mechanics and Found. Div., no SM 4, p. 1267-1287, illus., table, 1970.

The Pittsburgh area [Pa.] exhibits two distinct subsidence problems, active mining at depths of 300 feet or more beneath the surface, and structures located over old mine workings at relatively shallow depths. In the first, subsidence damage is prevented by leaving coal pillars in place to support the ground surface. In the second, the method of support selected is dictated by cost and degree of risk the owner is willing to accept. Each site presents a unique problem and extensive investigation is required, involving study of mine maps, borings drilled to the mine level, borehole photography, and where possible, opening and inspecting the mine. Methods of support are reviewed and examples of subsidence damage and support methods are presented as case histories. — ASCE abstract

03073 **Green, Don W.; Dabiri, Hassan; Weinaug, Charles F.; Prill, Robert.** Numerical modeling of unsaturated groundwater flow and comparison of the model to a field experiment: Water Resources Research, v. 6, no. 3, p. 862-874, illus., tables, 1970.

A mathematical model describing isothermal two-phase flow in porous media, consisting of describing differential equations and algorithms for their numerical solution, was applied to the problem of vertical ground-water movement in unsaturated

soils in the absence of evaporation and transpiration. The second-order, nonlinear partial differential equations describing water-air flow, were converted to finite difference form and were solved with a digital computer using an iterative implicit procedure. The model includes effective permeabilities of each phase and capillary pressure as functions of liquid saturation. Properties may be varied as functions of position. Results were compared with experimental field data on moisture movement beneath a shallow surface pond, and excellent agreement between calculated results and the data was obtained. The mathematical model could be used to describe soil moisture movement during wetting and drying periods. — *from* Authors' abstract

03581 **Green, John; Weiblen, Paul.** A teacher's guide for geologic field investigations in northeastern Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, 21 p., illus. [n.d.].

These investigations are divided into two groups: the vicinity of Duluth and northeast, by Green; and the area southwest of Duluth by Weiblen. The oldest rocks are in a belt extending across the northern part of the State. Granitic intrusions and metamorphism belong to the Algoman Orogeny. The next event was the outpouring of tens of thousands of feet of basaltic lava flows in the Lake Superior area, penetrated by complex bodies, including gabbroic plutons. Stops include Cloquet Esker, Duluth Gabbro Complex and Glacial Lake Duluth, Keweenawan Basalt with crossbedded sandstone, glacial and stream erosion, and glacial lake sediments. The area southwest of Duluth provides an opportunity to see effects of regional metamorphism on a succession of Precambrian sedimentary rocks. — ESL

03052 **Greenfield, Leonard J.; Hamilton, Robert D.; Weiner, Catherine.** Nondestructive determination of protein, total amino acids, and ammonia in marine sediments [with Spanish abs.]: Bull. Marine Sci., v. 20, no. 2, p. 289-304, illus., tables, 1970.

A method is described whereby the amounts of ammonia and amino acids in sediments are measured by color reaction with hydrindantin-ninhydrin reagent. Both substances are measured together to give a total value. The ammonia in a separate sample diffuses into boric acid and is then treated with the reagent. The total value less the value for ammonia gives the amount of amino acid. The determination of protein involves its solution in NaOH and reaction with biuret reagent to give a product detectable by ultraviolet light. Sensitivity is 0.020-0.150 μM NH_3-N or amino-N per ml, and 0.02-0.2 mg protein per ml of final solutions. — Authors' abstract

03515 **Gricius, Anthony.** Rare twinned quartz crystals in a geode: Earth Sci., v. 23, no. 5, p. 222-224, illus., 1970.

A geode was found near Griggsville, Ill., about 10 inches in diameter and lined with drusy quartz crystals, every one of which seems to be a rare Dauphiné penetration twin with reentrant angles. — ESL

03368 **Griffiths, J. C.** Current trends in geomathematics: Earth-Sci. Rev., v. 6, no. 2, p. 121-140, illus., tables, 1970.

In the next decade the problems with the greatest public impact appear to be the ones which will receive the greatest emphasis and support. This will require that the geosciences comprehend exceedingly complex probabilistic systems and these, in turn, demand the use of operations research, cybernetics, and systems analysis. Such a development may well lead to a change in the paradigms underlying geoscience; they will certainly include more realistic models of "real world" systems and the tool of simulation with cybernetic models may well become the basis for rejuvination of experimentation in the geosciences. — *from* Author's summary

03402 **Griggs, G. B.; Kulm, L. D.** Physiography of Cascadia deep-sea channel: Northwest Sci., v. 44, no. 2, p. 82-94, illus., tables, 1970.

This channel originates between large sea fans off Oregon and Washington, widens southward across Cascadia Abyssal Plain, goes west through Blanco fracture zone in

a deep V-profile reduced by impinging seamounts from 1850 to only a few meters wide, plunges into a basin, and then turns south and west to cross Tufts Abyssal Plain. Buried ridges and seamounts of Juan de Fuca Rise and the fracture zone both impede bottom transport and are sources of sediment. On the west, tributary Vancouver Sea Valley's broad floor hangs 60 m above the main channel. Interruptions in gradually decreasing gradient may be a result of slumped channel walls; shallowing, near fans and on Tufts plain, is due to height changes in banks; most levees are on the steep, generally higher right bank. Acoustic reflection profiles show basement lows beneath the channel at nearly all crossings. — GDC

03706 **Grim, Muriel S.; McManus, Dean A.** A shallow seismic-profiling survey of the northern Bering Sea: Marine Geology, v. 8, no. 5, p. 293-320, illus., 1970.

Shallow, continuous seismic-profiling records were obtained along a 3,900 km track in the northern Bering Sea. The deepest of five reflectors probably represents pre-Tertiary rocks; these are overlain by a thick sequence of sediments represented by parallel reflectors. These have undergone faulting and gentle folding. In the western half of the area their upper surface has been subaerially eroded, whereas in the eastern half it has not. In the eroded area there are indications of buried glacial deposits. Overlying the parallel reflectors near the Yukon delta is an extensive Yukon River deposit of presumed late Quaternary age. The present sea floor contains features suggesting both erosional and constructional remains of former sea level stillstands. — *from* Authors' abstract

03611 **Gross, David L.; Moran, Stephen R.** A technique for the rapid determination of the light minerals of detrital sands: Jour. Sed. Petrology, v. 40, no. 2, p. 759-761, 1970.

Determination of light minerals of detrital sands by etching and staining procedures is greatly facilitated with the use of a black roofing tar mounting medium. This medium is unaffected by hydrofluoric acid etching and provides a convenient dark background for counting stained grains with reflected light. The technique is particularly suited for the determination of quartz, chert, and feldspar percentages of large numbers of samples. — Authors' abstract

03669 **Gross, David L.** (compiler). Geology for planning in De Kalb County, Illinois: Illinois Geol. Survey Environmental Geology Note 33, 26 p., illus., 1970.

The purpose of this study was to furnish geologic information on De Kalb County, Ill., relative to waste disposal, availability of ground water and construction materials, and suitability of the land for highways, subdivision development, and septic systems. Surficial deposits were mapped to a depth of 20 feet; bedrock is described briefly. Other maps at a scale of 1:25,000 cover aquifer conditions, and sand and gravel resources. Interpretive maps on suitability for solid-waste disposal and suitability for general construction are based on the surficial geology and many other factors. — EH

03421 **Gross, M. Grant.** New York metropolitan region, a major sediment source: Water Resources Research, v. 6, no. 3, p. 927-931, illus., table, 1970.

Approximately 9.6 million tons per year of waste solids, including dredged sediment and construction debris from the New York metropolitan region, was dumped in New York Bight and in western Long Island Sound between 1964 and 1968. This was apparently the largest sediment source discharging directly into the North Atlantic Ocean (excluding the Gulf of Mexico) from the North American continent. Considering the core metropolitan region (population about 9 million) as the dominant source, the average annual discharge was about 1 ton per person (equivalent to about 6 pounds per person per day). — Author's abstract

03744 **Grossman, I. G.; Wilson, William E.** Hydrogeologic data for the lower Housatonic River basin, Connecticut: Connecticut Water Resources Bull. 20, 52 p., illus., tables, 1970.

Tabulated data (most collected from 1965-67) include records of 261 wells and logs of 85 wells and 456 test holes. Laboratory analyses of stratified-drift samples and records of pumping tests of wells are included. — MCM

Guensburg, Thomas E. *See* Clark, John. 03574

Guidoboni, R. J. *See* Evans, C. A., Jr. 03666

Gutentag, Edwin D. *See* Meyer, Walter R. 03768

Gutiérrez-Estrada, Mario. *See* Reimnitz, Erk. 03533

Hafner, Stefan S. *See* Virgo, David. 03175

03513 **Hales, A. L.; Roberts, J. L.** The travel times of S and SKS: Seismol. Soc. America Bull., v. 60, no. 2, p. 461-489, illus., tables, 1970.

Observations are reported of traveltimes of S and SKS for arc distances of 30° to 126°. It was found that for S the new times do not differ significantly from the Jeffreys-Bullen tables up to 80° and are up to 4 seconds later between 80° and 100°. The apparent velocity found for the diffracted S phase was 1/8.941° per second agreeing well with that reported by Cleary. The S station anomalies found in this study were about four times those for P in agreement with the earlier analysis of Doyle and Hales. As was the case for P, the traveltimes for S can be fitted to within experimental error by a quadratic in Δ. However, in this case, the values of $dT/d\Delta$ found from the raw data suggest that there is a discontinuity in $dT/d\Delta$ at about 42°. — Authors' abstract

Hales, Anton L. *See* Cleary, John. 03360

Hall, M. R. *See* Dietrich, R. V. 03749

03653 **Hall, Stephen A.** Nomenclature of some Pennsylvanian Upper Cherokee (Desmoinesian Series) coals of Iowa: Iowa Acad. Sci. Proc. 1969, v. 76, p. 275-281, 1970.

This review of the history of nomenclature of the coal beds begins with the 1870 geological survey; five coals were named by St. John at that time. The Panora, described in Guthrie County, in 1927 was renamed Whitebreast by Lugn for exposures in Lucas County within a half mile of St. John's type section of the Wheeler Coal. The Bevier Coal has been interpreted as splitting, the lower bench being called the Wheeler and the upper the Bevier. A palynological investigation by Habib indicated that the lower bench was not the Wheeler. The Bevier is poorly documented in Iowa. The Lacona Coal occurs 20-40 feet below the Whitebreast and may be important only locally. The Marshall and Lonsdale coal beds occur in the Marmaton Group above the Cherokee. — ESL

03235 **Hamelin, Louis Edmond.** Contribution au vocabulaire géographie des pays froids – Périglaciaire et glaces flottantes [Contribution to the geographic vocabulary of the cold regions – Periglacial and floating ice (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 305-309, 1970.

The author suggests variations of the term *periglaciaire* and standardization of terms used to describe floating ice. — EH

03725 **Hamilton, E. L.; Bucker, H. P.; Keir, D. L.; Whitney, J. A.** Velocities of compressional and shear waves in marine sediments determined in situ from a research submersible: Jour. Geophys. Research, v. 75, no. 20, p. 4039-4049, illus., tables, 1970.

In situ measurements of velocity and attenuation of compressional waves, and velocities of Stoneley waves from which shear-wave velocities were computed, were made at four stations in the sea floor off San Diego, Calif. Sediment types and water depths ranged from medium sand at 20 m to clayey silt at 986 m. Sediment densities, porosi-

ties, and grain sizes were measured in samples from each station. These data allow tentative evaluations of models and equations, and computations of constants for elastic and visco-elastic saturated, porous media. Either Hookean-elastic or viscoelastic equations can be used to compute compressional-wave and shear-wave velocities and other elastic constants. A 'viscoelastic' solid model is used to account for absorption in sediments. It is concluded that almost all open-ocean sediments have finite rigidities and transmit shear waves. — *from* Authors' abstract

03558 **Hamilton, Edwin L.** Sound velocity and related properties of marine sediments, North Pacific: Jour. Geophys. Research, v. 75, no. 23, p. 4423-4446, illus., tables, 1970.

The following properties are tabulated and illustrated in diagrams that interrelate various properties of marine sediments from sedimentary environments associated with the continental terrace, deep-water abyssal plain, and abyssal hill physiographic provinces of the North Pacific: grain size, bulk density, density of mineral grains, porosity, sound velocity, velocity ratio, impedance, and density X (velocity)^2. When porosity-velocity relations are entered into diagrams or equations for a single environment, velocity is usually predictable within 1 to 2 percent. Mean grain size has one of the best empirical relationships with velocity. Impedance and density X (velocity)^2 can be determined from porosity and density. There is no usable relationship between sound velocity and shear strength. — DBV

Hamilton, Robert D. *See* Greenfield, Leonard J. 03052

03583 **Hamilton, Robert M.** Time-term analysis of explosion data from the vicinity of the Borrego Mountain, California, earthquake of 9 April 1968: Seismol. Soc. America Bull., v. 60, no. 2, p. 367-381, illus., tables, 1970.

Aftershocks of the magnitude 6.5 earthquake of 9 April 1968 near Borrego Mtn., Calif., were recorded by 20 portable seismographs during a two-month period beginning two days after the main shock. Near the end of the recording period, three explosions were set off to obtain station time corrections and a crustal model for use in locating aftershocks. Data were analyzed by the time-term method using P_g arrivals in the interval 15 to 82 km. Time-term values, which range from 0 to 1 1/4 sec, correlate well with the lithology: low values for stations on or near pre-Tertiary granitic rocks, intermediate values on Tertiary sediments, and high values on Quaternary alluvium. A consistent relation is exhibited between time terms and basement depths, suggesting that basement depths can be estimated from time terms. A velocity of 5.93 kmps was found for P_g waves. Later arrivals indicate an intermediate layer at a depth of 14 km. — *from* Author's abstract

03438 **Hammond, Stephen R.** Paleomagnetic investigations of deep borings on the Ewa Plain, Oahu, Hawaii: Hawaii Inst. Geophysics [Rept.] HIG-70-10, 60 p., illus., 1970.

Two core holes, 1107 and 544 feet deep, drilled on Ewa Coastal Plain, penetrated the sequence of reef and nearshore deposits and ended in basalt. Over 75 samples from both cores were analyzed for NRM vector position and intensity; a stratigraphic polarity sequence is presented for each core. The dominant lithology was unaltered coralline, skeletal, micritic limestone containing detrital (titano) maghemite as the principal magnetic mineral. Study results do not conclusively relate sedimentary sections in cores to a definite period of geologic time. Age of the Ewa I section between 618-1072 feet may lie between 1.62-3.32 m.y., 1.79-3.92 m.y., or 1.79-2 m.y. B.P. Radiometric dates indicate only that strata below 898 feet are older than 700,000 yr. All three correlations imply that the lower 350-450 feet of Ewa I strata accumulated prior to the Pleistocene. Ages for the Ewa II section are more uncertain due to lack of radiometric control, presence of soils, and subaerial erosion. — *from* Author's abstract

03538 **Hanai, Tetsuro.** Studies on the ostracod subfamily Schizocytherinae Mandelstam: Jour. Paleontology, v. 44, no. 4, p. 693-729, illus., tables, 1970.

Studies of morphologic structures of podocopid Ostracoda with schizodont hingement, and evidence from the geographic and stratigraphic (Cretaceous-Holocene) distributions of their character complexes, lead to the conclusion that the seven known schizodont genera should be placed in two tribes, the Schizocytherini and Paijenborchellini, of the subfamily Schizocytherinae (family Cytheridae). The Schizocytherinae are most closely related to the Paracytherideinae. Four new species, one of *Schizocythere*, and three of *Paijenborchella*, are described from Japan. Geographic and stratigraphic distributions of these genera and of *Eopaijenborchella*, *Neonoceratina*, *Sulcocythere*, *Palmenella* are plotted on world maps; *Eopaijenborchella*, *Paijenborchella*, *Palmenella* occur, fossil and living, in North America as well as in the Old World. — VMJ

03406 **Hansen, R. O.; Begg, E. L.** Age of Quaternary sediments and soils in the Sacramento area, California, by uranium and actinium series dating of vertebrate fossils: Earth and Planetary Sci. Letters, v. 8, no. 6, p. 411-419, illus., tables, 1970.

Nuclide activities of U-238, U-234, and Th-230 in some of the bones of a Rancholabrean aged faunal assemblage range from 43 dpm/g to 298 dpm/g and high P-231 activities were detected in a few bones. The method dates the Riverbank Formation east of Sacramento, Calif., and the overlying San Joaquin soil as 103,000 ± 6,000 yr. Where ground water has been present, absorption of U by fossils was rapid, the mean residence times of U are higher and equal to total elapsed time. U-234/U-238 ratios are lower in wetter zones where water facilitates some remixing of U isotopes. Losses of U from some of the fossils are related to carbonate leaching and windows in the hardpan where rain water has penetrated, resulting in excess Pa-231 activities. — *from* Authors' abstract

Harder, Hermann. *See* Lehmann, Gerhard. 03328

03030 **Hardy, Léon.** Sur les conditions hydroloqiques (salinité et température) du golfe de Laflamme, région Alma-Arvida [Hydrologic conditions (salinity and temperature) of the gulf of Laflamme, Alma-Arvida region (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 333-339, illus., table, 1970.

The marine episode began in the Lac-Saint-Jean lowland when the coastal region was elevated by isostasy, and water was confined in the Saguenay basin to form the gulf of Laflamme. Typical marine conditions existed, a fact corroborated by the presence of euryhaline mollusks and some shellfish. Salinity could not have been more than 20 percent at depth and 10 percent at the surface. Fossil evidence indicates that an arctic climate prevailed during the marine period, with a later warmer period when the temperatures reached 6 to 15° in the summer, about 8,700 B.P. — EH

03450 **Harmon, Russell S.** The chemical evolution of cave waters, Inner Space Cavern, Texas: Caves and Karst, v. 12, no. 1, p. 1-8, illus., tables, 1970.

The cave is developed in the Edwards Formation near Georgetown, Tex., along joints and faults of the Balcones zone. Objectives of the study were to determine factors influencing deposition of calcium carbonate around the Flowing Stone of Time, the state of saturation of associated waters with respect to calcite and dolomite, and to supply and interpret analytical data concerning the carbonate solution and deposition by ground water in the dolomite of the lower Edwards. Evolution of the waters involves three phases, absorption of carbon dioxide in the soil zone, solution of carbonate bedrock, and adjustment to the cave atmosphere. Cave waters from five areas associated with the speleothem were sampled periodically for three months. Measurements of pH were taken at the cave, and temperatures were determined. Calcium concentration greatly exceeds magnesium. Precipitation of calcite is greater during dry periods. — ESL

03528 **Harrington, Lyn.** The Columbia Icefield: Canadian Geog. Jour., v. 80, no. 6, p. 202-205, illus., 1970.

In contrast to the recession of the first part of the century, a large proportion of the glaciers today are more in balance with the present climate. The Columbia Icefield,

110-150 sq mi in area, lies astride the Alberta-British Columbia border, and is a three-way continental divide, with nine major glaciers and a score of smaller tongues. The central accumulation area is 2,000 to 3,000 feet thick. Three major glaciers are described, Columbia, Saskatchewan, and Athabasca. The latter is better known because it is more accessible, and glaciological studies have been made on its toe. Meltwater discharge from the Athabasca may exceed 40 million gallons a day in summer. — ESL

Harris, D. C. *See* Petruk, W. 03494

03497 **Harris, D. C.; Cabri, L. J.; Kaiman, S.** Athabascaite, a new copper selenide mineral from Martin Lake, Saskatchewan: Canadian Mineralogist, v. 10, pt. 2, p. 207-215, illus., tables, 1970.

Athabascaite is a new copper selenide from the Lake Athabasca area, northern Saskatchewan. Electron probe microanalyses gave $Cu^{5.11}Se_{4.0}$ and $Cu_{5.10}Se_{3.48}S_{0.32}$. The X-ray powder data can be indexed on an orthorhombic cell with $a = 8.227$, $b = 11.982$, $c = 6.441$ A. The strongest lines are 3.235(10), 3.015(6), 1.997(8), 1.893(5), 1.817(3), 1.664(4). With $Z = 4$, G (calc.) is 6.59. The mineral occurs as lath-shaped inclusions in umangite and as stringers and veinlets in hematite-stained carbonate vein material in basalt. In reflected light it is strongly bireflecting with colors in air ranging from light grey to bluish grey, like klockmannite. Anisotropism is very distinct with polarization colors white to dark blue. Reflectivity and microhardness values are given. Attempts to synthesize the mineral above 100°C were unsuccessful. — Authors' abstract

Harris, D. C. *See* Cabri, L. J. 03500

Harris, D. C. *See* Manning, P. G. 03503

Harrison, John. *See* Keulegan, Garbis H. 03739

03304 **Hasegawa, H. S.** Short-period P-coda characteristics in the eastern Canadian shield: Seismol. Soc. America Bull., v. 60, no. 3, p. 839-858, illus., tables, 1970.

The short-period P-coda of eight earthquakes and underground nuclear events are analyzed in both the time and frequency domains in order to determine the transmission characteristics of the crust in the eastern Canadian Shield. There is appreciable anomalous P-S conversion, starting at the base of the Labrador trough and extending to the upper mantle. The horizontal transfer function may be more unstable over this region than the vertical. It is concluded that: (1) where there is a surface layer of Proterozoic sediments about 1 km thick overlying basement rocks, the short-period body-wave transmission characteristics are more like those of the western Canadian sedimentary basin than those of the western Canadian Shield, and (2) to resolve both thin and thick crustal layers by means of the spectral ratio test, both short- and long-period records of the P coda are required. — *from* Author's abstract

Haskin, Larry A. *See* Cullers, Robert L. 03349

03066 **Hatcher, Robert D., Jr.** Structure of the Dumplin Valley fault zone in east Tennessee: Tennessee Div. Geology Rept. Inv. 29, p. 85-96, illus., reprinted 1970; originally published 1969.

This paper is reprinted from Southeastern Geology, v. 11, no. 2, 1969; *see* Abstracts of North American Geology, August 1970.

03754 **Hatten, C. W.; Meyerhoff, A. A.** The Caribbean area, a case of destruction and regeneration of a continent – Discussion [of paper by V. Škvor, 1969]: Geol. Soc. America Bull., v. 81, no. 6, p. 1855-1962, illus., 1970.

Škvor's article (ibid., v. 80, no. 6, p. 961-968, 1969) is criticized on the basis of his apparent lack of familiarity with both the literature and field geology of the Caribbean area, particularly Cuba. This is reflected in the inclusion of much outdated and

inaccurate information. Factual errors are pointed out, and a supplementary list of references is given. — VSN

Havard, Christina Jean. *See* Norris, D. K. 03477

Hawley, J. E. *See* Culberson, Charles. 03293

Hayatsu, A. *See* Gittins, J. 03435

Hays, J. F. *See* Mao, Nai-Hsien. 03730

03364 **Hedge, Carl E.; Hildreth, R. A.; Henderson, W. T.** Strontium isotopes in some Cenozoic lavas from Oregon and Washington: Earth and Planetary Sci. Letters, v. 8, no. 6, p. 434-438, illus., table, 1970.

The Sr-87/Sr-86 ratios have been determined in 22 volcanic rocks from Oregon and Washington. The emphasis of the study was on andesites and dacites, but several basalts were included. Most of the samples have a very limited range in strontium isotopic composition and all fall within variations previously defined for oceanic basalts. There are no systematic differences between lavas erupted through pre-Cenozoic basement and those erupted in the Columbia River embayment. It is concluded that the role played by crustal rocks in the generation of these andesites and dacites is minor or nonexistent, but assimilation of crustal material may have been a factor for some of the basalts of the Columbia River Group. — Authors' abstract

03549 **Heede, Burchard H.** Morphology of gullies in the Colorado Rocky Mountains [with French abs.]: Internat. Assoc. Sci. Hydrology Bull., v. 15, no. 2, p. 79-89, illus., tables, 1970.

A classification of gullies into discontinuous and continuous channels not only expresses differences in channel morphology and stage of development, but also presents helpful criteria for design of gully control. The term critical location was introduced for those locations within gullies that are obviously susceptible to changes, and whose direction of change is suggested. Regression analyses underlined the fact that the gullies constituted channels of youthful stage if relations between components in channel geometry were considered. — Author's abstract

Helander, D. P. *See* Karaoguz, Dogu. 03519

03507 **Helmberger, Donald V.; Morris, Gerald B.** A travel time and amplitude interpretation of a marine refraction profile — Transformed shear waves: Seismol. Soc. America Bull., v. 60, no. 2, p. 593-600, illus., 1970.

Generalized ray theory is used to investigate primary to shear mode conversion at the ocean bottom. A homogeneous, plane layered model is assumed. The transient response in the ocean is computed for those rays that traverse the solid layers exclusively in the shear mode. Synthetic seismograms are computed by convolving the response with the source pulse shape and instrumentation function. A profile of observations and synthetics are compared for a proposed model. This comparison is made for the same profile in which the P-velocity structure was determined previously. The crustal elastic parameters are well-determined by the combined analysis. — Authors' abstract

03142 **Hem, John D.** Study and interpretation of the chemical characteristics of natural water (2d edition): U.S. Geol. Survey Water-Supply Paper 1473, 363 p., illus., tables, 1970; originally published 1959.

The first edition (1959) of this paper no longer gives a satisfactory indication of present-day techniques of water-analysis interpretation or of state of development in the field of water chemistry. Therefore, this revision aims to outline more completely the principles and process, chemical and environmental, which shape and control the chemical composition of natural water; and to update the discussions of chemistry of individual constituents, methods of data interpretation, and associated bibliographic

references. A somewhat more extensive use of theoretical chemistry has been introduced for users with some chemical training. The interdisciplinary nature of the field requires introduction of considerable material which can be discussed only briefly. — GDC

03258 **Henderson, Barry Keith.** A mathematical model of some Pennsylvanian stratigraphy [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5100B, 1970.

Henderson, W. T. *See* Hedge, Carl E. 03364

Henika, William S. *See* Conley, James F. 03762

03673 **Henrikson, Paul; Nash, Raymond A., Jr.** A statistical analysis of errors in gravimetrically computed vertical deflections: Jour. Geophys. Research, v. 75, no. 20, p. 4017-4028, illus., table, 1970.

In general, vertical deflections are obtained either by astrogeodetic methods or by gravimetric methods. In the latter approach, gravity anomaly measurements are processed by using the so-called Vening Meinesz equations to yield the vertical deflections. These calculated values of vertical deflections differ from the true values for two reasons: the measurements of the gravity anomalies are subject to error, and a numerical algorithm must be used to approximate the Vening Meinesz equations. In this paper, the autocorrelation functions of the deflection errors arising from these two sources are determined under the assumption that the anomalies and the error in measuring the anomalies are random processes. — Authors' abstract

Herbert, L. R. *See* Sumsion, C. T. 03063

03348 **Herman, Yvonne.** Arctic paleo-oceanography in late Cenozoic time: Science, v. 169, no. 3944, p. 474-477, illus., table, 1970.

Sediment cores from the Arctic Ocean yield significant faunal and lithologic evidence of alternating cold and milder periods for the last 6 million years. Although high-latitude continental glaciation commenced prior to 6 million years ago, the Arctic Ocean remained free of permanent pack ice up to approximately 0.7 million years ago, after which successive ice-covered and ice-free conditions existed. — Author's abstract

Herrmann, Robert B. *See* Gordon, David W. 03309

03065 **Hershey, Robert E.; Wilson, John M.** Anomalous zinc in water wells, northeastern Henry County, Tennessee: Tennessee Div. Geology Rept. Inv. 27, 11 p., illus., tables, 1970.

A maximum of 41 ppm zinc is present in well water in the Dr. Kaiser well in Cypress Creek area; nearby wells contain anomalous amounts in lesser concentrations. Analysis of rock cuttings from a test well adjacent to the Dr. Kaiser in the Fort Payne Formation showed anomalous zinc in increasing concentration with depth; analysis of well water showed lower values but proved some of the zinc is in noncontaminated water. All soil samples containing more than 200 ppm zinc are within 10 mi of the contact between Mississippi embayment sediments and Paleozoic rocks; fractures, common along this contact, may have been avenues for transportation of zinc in ground waters. Increase in zinc content with depth may indicate a carbonate halo overlying a sulfide anomaly, or it may represent concentration of syngenetic zinc by downward-percolating ground water. — *from* Authors' abstract

03589 **Hester, B. W.** Geology and evaluation of placer gold deposits in the Klondike area, Yukon Territory: Inst. Mining and Metallurgy Trans., Sec. B., v. 79, Bull. 762, p. B60-B67, illus., tables, 1970.

Deposits of placer gold occur in valleys sporadically throughout the nonglaciated terrain in the interior plateau of Yukon. Extensive placers along streams on the divide

between the Indian and Klondike Rivers have been enriched by a rejuvenation of the drainage system; mined for 60 years by dredging, reserves were evaluated on the basis of spaced churn-drilling results. Compared with actual values recovered, low-grade deposits were consistently undervaluated and high-grade deposits overvaluated. Generally, drilling served to differentiate areas of value from waste, but contributed little to precise knowledge, and permafrost compounds the problems. Distribution maps of gold values produced in bedrock show that drill-holes were too widely spaced to disclose the many rapid variations. Historical experience and geological interpretation can help reduce these variations. — *from* Author's synopsis

03455 **Hewitt, D. F.; Vos, M. A.** Urbanization and rehabilitation of pits and quarries [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 283, 1970.

03035 **Hewitt, William P.** Construction hazards in Utah, *in* Governor's conference on geologic hazards in Utah, December 14, 1967: Utah Geol. and Mineralog. Survey Spec. Studies 32, p. 19-20, illus., 1970.

Trench cave-ins occur in nearly every kind of sediment and for a variety of geologic reasons. Foundation subsidence around Salt Lake City results from the great vertical and horizontal variability of local sedimentary facies. It is recommended that topographic mapping should be completed and updated for planning of dam and reservoir sites; geologic mapping should be accelerated to aid in evaluation of zoning codes; all dams built in high-risk areas should require approval of foundation and design engineers; and after excavation for a dam, the site should be checked for suitability of geologic conditions by a qualified geologist before construction proceeds. — MCM

Heymann, D. *See* Taylor, G. J. 03640

Heymann, Dieter. *See* Mazor, Emanuel. 03159

High, Lee R., Jr. *See* Picard, M. Dane. 03604

Hildreth, R. A. *See* Hedge, Carl E. 03364

03683 **Hjelmfelt, Allen T.; Lenau, Charles W.** Nonequilibrium transport of suspended sediment: Am. Soc. Civil Engineers Proc., v. 96, paper 7430, Jour. Hydraulics Div., no. HY 7, p. 1567-1586, illus., 1970.

The nonequilibrium transport of suspended sediment in an open channel is studied at an abrupt change from a nonerodible to an erodible bed. The convective-diffusion equation is solved for the case of constant velocity distribution and parabolic eddy diffusion coefficient. Diffusion in the direction of flow is neglected. Graphs of the concentration distribution, the channel-depth average concentration and the scour rate are presented. — ASCE abstract

03259 **Hobday, David Kenneth.** Upper Carboniferous shorelines systems in northern Alabama [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5100B, 1970.

03152 **Hobson, George D.** Hammer refraction seismic survey to assist biogeochemical program, Huckleberry Mountain, British Columbia, App. D *in* Biogeochemical prospecting for copper in west-central British Columbia: Canada Geol. Survey Paper 69-49, p. 29-39, illus., table, 1970.

In a hammer seismic survey along three lines over this Kennco property in 1967, 96 reversed refraction seismic profiles were obtained at 100-ft intervals. The central mound structure is a quartz diorite stock surrounded by Middle Jurassic sediments and volcanics of the Hazelton Group, including graywacke, tuff, andesite and argillite. The area has been glaciated several times leaving till on the bedrock and a sandy outwash cover. A histogram depicts seismic velocity versus frequency of occurrence; velocities appear to be more than 8700 feet per sec. Over portions of the profiles, it is possible to distinguish between dry surface materials, underlying outwash material, and till. The overburden varies in thickness from about 6 to 68 feet. All basic and computed data are tabulated. — GDC

03713 **Hodge, Dennis S.; Smith, Bruce D.; Smithson, Scott B.** Quantitative geophysical study of petrogenesis of syenites related to Laramie anorthosite, Wyoming, U.S.A.: Lithos, v. 3, no. 3, p. 237-250, illus., table, 1970.

Pyroxene and hornblende syenites comprise the northern border of the Laramie anorthosite. The syenites intrude regional gneisses that are metamorphosed in the middle to upper amphibolite facies. The chemical and mineralogical composition of these syenites closely resemble syenites from other anorthosite complexes. A trend of positive gravity anomalies follows the syenites and peaks over norite exposed within syenite; however, densities of syenite are lower than most other rocks in the area. Gravity interpretation shows the syenites are underlain by dense rocks which are probably norite, and that the mass of dense rocks is about 3 times as great as the mass of the syenite. This interpretation suggests that the syenites were formed by partial melting by norite or, more likely, were formed by differentiation from norite associated with anorthosite. — Authors' abstract

03425 **Hoerle, Shirley E.** Mollusca of the "Glades" unit of southern Florida — Pt. 2, List of molluscan species from the Belle Glade rock pit, Palm Beach County, Florida: Tulane Studies Geology and Paleontology, v. 8, no. 2, 56-68, 1970.

A borrow pit south of Belle Glade, Fla., has yielded 165 species of Pelecypoda, 8 species of Scaphopoda, and 261 species of Gastropoda from the "Glades" unit, a shell bed of early Pleistocene(?) age. About 15 percent of the species are extinct; the rest are found living today in Florida and Caribbean waters. The species are listed under families; each species is followed by coding for abundance and an abbreviated reference to a published figure; complete references are also listed. The fauna consists predominantly of open-sea forms, but brackish, fresh-water, and land facies are also present; nonmarine gastropods are listed separately. — VMJ

03564 **Hoffman, B. W.; Wainerdi, R. E.** KRIS, a computer program for the least-squares resolution of gamma-ray spectra by half-life and gamma-ray energy: Jour. Radioanal. Chemistry, v. 4, no. 2, p. 375-382, illus., tables, 1970.

KRIS offers the capability of resolving complex γ-spectra, even when spectra of the individual components are quite similar. A scheme is employed which allows for the use of half-lives as well as γ-ray energies in the least-squares resolution of γ-spectra. Options are also supplied for averaging of repetitive counts, least-squares smoothing of the data, iterative improvement of the weighting factors used in the least-squares solution, and use of either live or clock time counts. The number of control cards required for each sample has been minimized to simplify input. KRIS is written in FORTRAN IV and is being run under Fortran G and the Watfor compiler on the IBM 360/65. — Authors' abstract

03260 **Hoffman, James Irvie.** The nature of calcium-organic complexes in natural solutions and its implications on mineral equilibria [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5101B, 1970.

03491 **Hogberg, Rudolph; Matsch, Charles L.** A teacher's guide for geologic field investigations in central Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, 17 p., illus., table [n.d.].

The investigations are divided into two groups, the first in the vicinity of St. Cloud, by Hogberg, and the second in central Minnesota, by Matsch. The purpose of the studies in the St. Cloud area is to observe the geology and its effects on the basic industry, granite quarrying. Two groups of rocks are quarried, the St. Cloud Gray, and 'younger granites,' both intruded in the Penokean orogeny. From middle Precambrian to Early Cretaceous the area underwent weathering and erosion. The seven stops describe rock types, intrusions, glacial deposits, structure and weathering, and stratigraphy. The trip to other areas in central Minnesota is primarily to study glaciation, and includes stops at the Lake Agassiz outlet area, Glacial River Warren; Wadena Drumlin field; Mille Lacs Lake area; and glacial deposits at Pine City. — ESL

Hohenberg, C. M. *See* Podosek, F. A. 03366

03606 **Holliday, D. W.** The petrology of secondary gypsum rocks, a review: Jour. Sed. Petrology, v. 40, no. 2, p. 734-744, illus., 1970.

Secondary gypsum rocks are divided into two main petrographic groups, porphyroblastic and alabastrine. They often occur together, but are thought to be distinct. The former is the first to form and sometimes dates from early diagenesis, and the latter includes a wide variety of related textures. Hydration fabrics vary from indefinite grains with irregular extinction to more perfectly defined granoblastic gypsum. Recrystallization of hydration gypsum leads to unequigranular granoblastic gypsum. Porphyroblastic gypsum may also recrystallize in conjunction with the alabastrine variety. Strontium and boron are released from some anhydrite rocks during hydration, and occur in the form of such minerals as celestite and proberite. Three reaction mechanisms may be possible, and late-stage displacive gypsum veins possibly form from the excess sulfate removed in solution during gypsification, or alternatively may precipitate from sulfate-rich connate waters. — *from* Author's abstract

03261 **Holt, Jack Haston.** A study of the physico-chemical, mineralogical and engineering properties of fine-grained soil in relation to their expansive characteristics [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5034B, 1970.

03514 **Hood, Peter.** Sea-floor spreading and continental drift: Canadian Geog. Jour., v. 80, no. 1, p. 32-36, illus., 1970.

The history of the concept of continental drift is traced from Sir Francis Bacon, through Wegener, to paleomagnetic studies which showed that polar wandering curves for North America and Europe would be brought together if the continents had been joined. One of the largest difficulties for the hypothesis, an explanation for the mechanism which moved the continents, was resolved by the idea of sea-floor spreading with convection currents rising under midocean ridges and descending at deep ocean trenches. Reversing of the Earth's magnetic field and formation of magnetic stripes on the ocean floor paralleling the midocean ridge, as revealed by magnetic surveys, are discussed. The magnetic stripes may be used to reconstruct continents, since movements would be at right angles to the stripes. — ESL

03409 **Hooper, P. R.; Rosenberg, P. E.** The petrology of Granite Point, southeastern Washington: Northwest Sci., v. 44, no. 2, p. 131-142, illus., table, 1970.

Deep in Snake River Canyon in Whitman County, western extensions of pre-basalt granitic hills and ridges, mainly of adamellite, crop out on both banks. They are coarsely granitic with biotite bands and elongated feldspars, and have darker sheet-like mafic segregations and light feldspathic segregations adjacent to dark green slickensided surfaces. Foliation, generally NE-SW and more distinct on erosion surfaces parallel to the river, is disturbed by a fault and also by sharp S-twisting on steep planes. The mineral constituents, with similar compositions in all three rock types, differ in proportions and crystal size; modal analyses reflect local variations. Inequigranular texture suggests granulation and recrystallization, which may explain ferromagnesian stringers and foliation. Large quartz and microcline crystals enclosing small quartz, plagioclase, and biotite, imply late growth in solid state, from metasomatizing fluids in fracture channels. — GDC

Hopkins, David M. *See* Scholl, David W. 03531

03022 **Hornbrook, E. H. W.; Allan, R. J.** Geochemical exploration feasibility study within the zone of continuous permafrost, Coppermine River region, Northwest Territories: Canada Geol. Survey Paper 70-36, 35 p., illus., tables, 1970.

During the summer of 1969, a geochemical exploration feasibility study in the Coppermine River Basalt Belt, just north of Dismal Lakes, Coppermine River area, N.W.T., was conducted to evaluate geochemical exploration methods in areas of continuous permafrost, and to detect copper mineralization in the basalt series. Analysis of samples of a variety of surficial materials was by hot nitric acid leach and atomic absorption spectroscopy. Results of biogeochemical studies indicate that flowering shrubs and certain lichens have an exploration potential. Dispersion of

metals by physical and chemical processes is sufficient to develop geochemical halos in lakes, stream sediments, and soils. — *from* Author's abstract

03151 **Hornbrook, E. H. W.** Biogeochemical prospecting for copper in west-central British Columbia (*with a contribution by* G. D. Hobson): Canada Geol. Survey Paper 69-49, 39 p., illus., tables, 1970.

New and modified methods for collection and preparation of plant and soil samples, and spectrographic analysis of organic material in mobile laboratories, were used to determine distribution of Cu-Mo and associated elements at Kennco's Huckleberry Mtn. deposit south of Smithers. The nearby Lucky Ship property of Amax (Hornbrook, 1969), is similar in altitude, forest cover, soils, host rock (Hazelton Group), and granitoid stock with associated mineralization. It is concluded: biogeochemical twig and needle results are as effective as geochemical soil results in detecting peripheral mineralized zones; Mo behavior in second-year alpine fir needles demonstrates breakdown of a partial exclusion mechanism and how this can be used to obtain accentuated distribution contrast; only copper and molybdenum were distributed with persistent relationship to the mineralized zones. Mo in fir needles is a particularly good indicator for copper-molybdenum deposits. — *from* Author's abstract

03642 **Horowitz, Alan Stanley.** Nomenclatorial diversity within *Fistulipora* McCoy and allied genera: Jour. Paleontology, v. 44, no. 4, p. 776-778, illus., tables, 1970.

A semi-logarithmic plot of the cumulative number (by 10-year periods) of 304 species names now assigned to the Paleozoic bryozoan genus *Fistulipora* reveals two straight line segments having a break in slope at 1890. Examination of the diversity of specific names in the genus leads to conclusions comparable to those of Weller (1952) for trilobite generic names. Seventeen homonyms of species of *Fistulipora* are listed. One homonym has been renamed (*F. romingeri* Nicholson and Foord, 1885, *pro F. crassa* Rominger, 1866, *non* Lonsdale, 1839, etc.); no new names are proposed for the remaining 16 homonyms. Nomenclature of the closely related genera *Cyclotrypa* and *Dybowskiella* is also discussed. — *from* Author's abstract

03502 **Hounslow, A. W.; Chao, G. Y.** Monoclinic chlorapatite from Ontario: Canadian Mineralogist, v. 10, pt. 2, p. 252-259, illus., tables, 1970.

Chlorapatite, a new occurrence at Bob's Lake, southeastern Ontario, is monoclinic with space group $P2_1/a$ and unit cell dimensions $a = 19.210$ A ($=2c$), $b = 6.785$ A, $c = 9.605$ A, $\beta = 120°$. It is optically biaxial, negative, with $\alpha = 1.665$, γ about equal to $\beta = 1.667$, 2V about equal to 10°. $D_m = 3.181$, $D_x = 3.172$. The chemical formula based on 25 cationic charges is $Ca_{4.93}(PO_4)_{3.02}Cl_{0.91}OH_{0.05}F_{0.04}$. The transitional (hexagonal to monoclinic) composition probably lies between 0.82 and 0.91 atom of chlorine per formula. — Authors' abstract

03031 **Housner, G. W.; West, P. J.; Johnson, C. G.** Analysis of ground motions at San Onofre Nuclear Generating Station April 9, 1968: Seismol. Soc. America Bull., v. 60, no. 3, p. 987-1000, illus., 1970.

The Borrego Mountain earthquake of 9 April 1968 produced ground shaking having 5 percent g maximum acceleration at the 450 M We San Onofre Nuclear Generating Station site. The recorded motion showed two distinct phases separated by about six seconds. The spectra of these phases differ markedly, presumably reflecting differences in source generation. There was no damage at the plant. More recently, a special seismic central accelerograph system has been installed to record the earthquake-induced motion of the concrete base of the containment structure and the response mption of the steam generators and pressurizer. Experience with the installation and operation of the expanded accelerograph system is reviewed with suggestions offered for alleviating problems due to system malfunction. — Authors' abstract

03043 **Housner, G. W.** Strong ground motion, Chap. 4 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 75-91, illus., tables, 1970.

The shaking of the surface of the ground as a result of passage of stress waves produced by an earthquake is examined. Earthquakes of M > 5.0 generate ground motions sufficiently severe to be damaging to structures. The nature of fault slip, the epicenter (emphasizing that instrumentally determined epicenter and hypocenter do not indicate center of energy release), intensity, ground motion, idealized ground motion (maximum acceleration, duration, spatial distribution), frequency of occurrence of earthquakes and of ground shaking, upper bound and intensity of ground shaking, influence of ground conditions, artificially generated motions, Fourier spectrum, and response spectrum are discussed. Numerous examples are cited from California. — VSN

03044 **Housner, G. W.** Design spectrum, Chap. 5 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 93-106, illus., table, 1970.

Recorded ground accelerations and response spectra of past earthquakes provide a basis for design of structures to resist earthquakes. Although individual spectra differ, certain standard characteristics are exhibited by recorded ground motions. It has been proposed that idealized spectrum curves be used as 'design spectrum' curves, which must be consistent with ground motions actually recorded in the past. The design spectrum is not a specification of a particular earthquake ground motion, but is a specification of relative strengths of structures of different periods. To specify strengths, damping and allowable design stresses must be prescribed; actual earthquake forces used in design will depend strongly on the assumed damping. Ground shaking that might be experienced at a particular location must be estimated; methods of establishing this, and measured building behavior and earthquake analysis and design are discussed. — VSN

03307 **Howell, B. F., Jr.; Lundquist, G. M.; Yiu, S. K.** Integrated and frequency-band magnitude, two alternative measures of the size of an earthquake: Seismol. Soc. America Bull., v. 60, no. 3, p. 917-937, illus., tables, 1970.

Integrated magnitude substitutes in the r.m.s. average amplitude over a pre-selected interval for the peak amplitude in the conventional body-wave magnitude formula. Frequency-band magnitude uses an equivalent quantity in the frequency domain. Integrated magnitude exhibits less scatter than conventional body-wave magnitude for short-period seismograms, and frequency-band magnitude less scatter than either body-wave or integrated magnitudes for both long- and short-period seismograms. The scatter of frequency-band magnitude is probably due in part to real azimuthal effects, in part to other factors. To observe azimuthal variations clearly, the crustal-transfer functions and seismograph response need to be known more precisely than was the case in this experiment, because these two sources of scatter can be large enough to explain all observed variations. — *from* Authors' abstract

Hower, John. *See* Reynolds, Robert C., Jr. 03119

03765 **Hoyaux, B.; Ladanyi, B.** Gravitational stress field around a tunnel in soft ground [with French abs.]: Canadian Geotech. Jour., v. 7, no. 1, p. 54-61, illus., 1970.

The finite element method has been used for determining the stress distribution and the displacement due to gravity around an unlined tunnel driven through a semi-infinite medium, characterized by three idealized material behaviors reflecting approximately a short-term behavior of natural undisturbed insensitive and sensitive clays. The knowledge of stress and displacement fields around an unlined tunnel can be used for evaluating the need for supports according to the acceptability of expected deformations. — Authors' abstract

03508 **Hron, Marie.** Radiation of seismic surface waves from extending circular sources: Seismol. Soc. America Bull., v. 60, no. 2, p. 517-537, illus., 1970.

The radiation of Rayleigh and Love waves from two different horizontal circular sources of stress is studied. The displacement on the free surface is deduced from the equations of motion and boundary conditions and then integrated over a finite radius to simulate a disturbance extending with a constant finite velocity. — Author's abstract

03262 **Huddleston, James Herbert.** Local soil-landscape relationships in eastern Pottawattamie County, Iowa [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 4872B, 1970.

Hudson, D. E. *See* Trifunac, M. D. 03032

03445 **Hudson, Donald E.** Ground motion measurements, Chap. 6 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 107-125, illus., table, 1970.

Instrumentation problems concerning dynamic type of ground shaking (ground accelerations inducing inertial forces in structures sufficient to damage it) are the major concern of this paper. Because of the increasing importance of slower ground motion and nonseismic fault motions now being observed and measured in California, a brief discussion is included of the special instrumentation problems they involve. Structural response determinations, accelerograph design principles and details, simplified instrumentation (measurement of ground motions by effects on a particular system), response spectrum, seismoscopes (direct measurement of response spectrum), strong-motion instrument networks, and future accelerograph development, are examined. Characteristics of strong-motion accelerographs in use as of 1968 are tabulated. — VSN

Hudson, J. D. *See* Busch, F. E. 03701

Hudson, Travis. *See* Sainsbury, C. L. 03334

Huebner, George L., Jr. *See* Merrell, William J., Jr. 03216

03537 **Huffman, Samuel F.** The ectoproct (bryozoan) *Rhombopora lepidodendroides* Meek, Late Pennsylvanian (Virgilian), Nebraska: Jour. Paleontology, v. 44, no. 4, p. 673-679, illus., tables, 1970.

The characters of *R. lepidodendroides*, the type species of *Rhombopora* Meek, 1872, are described, employing recently prepared thin sections and a biometric approach. The growth sequence thus demonstrated explains much of the variability in the species. A lectotype is selected from the original syntypic suite, collected by Marcou (1864) from a section at Nebraska City, and the remaining syntypes become lectoparatypes. — *from* Author's abstract

Hummel, F. A. *See* Kreidler, Eric R. 03174

03619 **Hunt, Bruce W.** Flow rates in two-dimensional, unsteady, confined groundwater flow — Closure [to discussion of paper 6451, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 7, p. 1611-1612, 1970.

Paper 6451 was published *in* ibid., v. 95, no. HY 2, p. 603-608, 1969; *see* Abs. North American Geology, Sept. 1969.

03621 **Hunt, Bruce W.** Nonsteady flow to surface reservoir — Discussion [of paper 7137 by W. W.-G. Yeh, 1970]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 7, p. 1663-1665, illus., 1970.

Paper 7137 was published *in* ibid., v. 96, no. HY 3, p. 609-618, 1970; *see* Abs. North American Geology, Nov. 1970. Some changes in equations for more accurate numerical solution are suggested. — GDC

Hunten, D. M. *See* Walker, J. C. G. 03223

03769 **Huntoon, Peter.** The deep structure of the Laramide monoclines exposed in the eastern Grand Canyon [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 65, 1970.

03308 **Husebye, Eystein; Madariaga, Raúl.** The origin of precursors to core waves: Seismol. Soc. America Bull., v. 60, no. 3, p. 939-952, illus., table, 1970.

The origin of the precursors of the core waves in the range 105°-142° is studied. Between 105° and 125° a long tail is observed after the P wave diffracted by the core. In the range $130° < \Delta < 142°$ we usually observe short-period onsets a few seconds before PKIKP; these are the waves called P(GH). Reflection at a discontinuity in the outer core, near the inner-core boundary, is shown to produce the P(GH) branch. Reflections in the outer core are rejected as a mechanism for the tail of the P diffracted wave. A theoretical study of diffraction of P by the core shows that higher modes of diffracted waves cannot explain the observations of the tail of P diffracted. We conclude, by elimination, that it is due to reflections or multiple paths in the upper mantle. — Authors' abstract

Hutchinson, R. W. *See* Suffel, G. G. 03461

03689 **Hutt, R. B.** The development and use of the Ontario Well Data System: Jour. Canadian Petroleum Technology, v. 9, no. 1, p. 52-59, illus., 1970.

Unlike other government systems for storage and retrieval of geologic data, the Ontario system is operated as a service for industry. A high proportion of operators are independents who would be unable to justify maintenance of a computer system, but from this system, they are able to receive posted structures or isopach maps of most geologic units. Some major companies have purchased the entire system package outright and are utilizing it within the framework of their own computer systems. Internally the Ontario system is used to prepare reports for 15′ quadrangles which coincide with the National Topographical Series. The first area chosen was in the Lambton County reef belt, the center of considerable interest and activity over the years and one which should reveal any weaknesses in the system as it now exists. — *from* Author's abstract

Hyndman, R. D. *See* Beaumont, C. 03408

03678 **Ida, Yoshiaki.** Thermodynamic problems related to growth of magma: Jour. Geophys. Research, v. 75, no. 20, p. 4051-4062, illus., table, 1970.

Thermodynamic equilibrium of a liquid surrounded by a solid is discussed to understand the behavior of magma produced by partial melting in the interior of the Earth. The equilibrium condition is different from the case in which both the liquid and solid phases are under the same hydrostatic pressure. The liquid in the solid, subjected to a stress field before the partial melting, cannot attain perfect equilibrium with the surrounding solid. The development of the solid-liquid boundary is estimated by numerical calculations. The effective melting point is reduced as a result of nonhydrostatic components. With the reaction the liquid part may develop into a thin film, accompanied by local concentration of nonhydrostatic stress. The present discussion supplements Griggs' shear melting hypothesis in its initial process. An explanation is proposed concerning the connection between earthquakes and volcanic activity. — *from* Author's abstract

Idriss, I. M. *See* Seed, H. Bolton. 03355

Idriss, I. M. *See* Seed, H. Bolton. 03635

03148 **Irish, E. J. W.** Halfway River map-area, British Columbia (94B): Canada Geol. Survey Paper 69-11, 154 p., illus., tables, geol. map, 1970.

This glaciated area of Interior Plains, Rocky Mountains and Foothills north of Peace River, is underlain by 25,000 feet of Precambrian to Late Cretaceous strata. In the Rocky Mountains are thrust faults, mostly west dipping, some folded, and Paleozoic formations with several unconformities; lithology, distribution, and probable age of each large unit are described. Folding persisted into the Mesozoic in the Foothills and Plains; in describing lithology, distribution and paleontology of each formation, existing names are used; there are unconformities at the top of the Fernie Formation and within the Lower Cretaceous sequence. Natural gas is produced in the northeast; large reserves of good coal are known within the Gething Formation. A site for a high dam was selected just below the head of Peace River Canyon. In pocket is accompanying geologic map 1232A (1968). — GDC

03751 **Irish, E. J. W.** The Edmonton Group of south-central Alberta: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 125-155, illus., 1970.

Upper Cretaceous deltaic and fluvial strata lying between the marine Bearpaw and nonmarine Paskapoo Formations on the eastern side of the Alberta Syncline have been called for many years the Edmonton Formation. The Whitemud and Battle units within the Edmonton succession have been correlated with formations of the same name in southeastern Alberta and are easily recognizable in outcrop, as well as being reliable lithologic markers above the Bearpaw. The Battle Formation is readily distinguishable on electric logs and is a datum for subsurface correlation. The Kneehills tuff bed within it is a time marker. Correlation, based on vertebrate dinosaurian fauna, permits assigning formational status to the Whitemud and Battle units. The name Horseshoe Canyon Formation is proposed for the nonmarine strata between the Bearpaw and Whitemud Formations. All three formations comprise the Edmonton Group. — *from* Author's abstract

03351 **Ishii, Hiroshi; Ellis, Robert M.** Multiple reflection of plane SH waves by a dipping layer: Seismol. Soc. America Bull., v. 60, no. 1, p. 15-28, illus., 1970.

The solution of the problem of a plane SH wave incident at the base of a dipping layer by multiple reflection for waves incident at any angle perpendicular to strike has been obtained for amplitude, phase, and phase velocity. Numerical values are calculated on the surface. For waves propagating in the up-dip direction the amplitude versus frequency curves for a constant depth to the interface change slowly with increasing dip for dip angles less than 20°; for waves propagating in the down-dip direction, the character of amplitude curves changes rapidly. In these cases the diffracted wave plays an important role. In addition to satisfying boundary conditions at the surface and between media, the diffracted wave must also satisfy additional conditions along a dipping surface lying between the free surface and the boundary between the two media. — *from* Authors' abstract

Ito, Jun. *See* Mao, Nai-Hsien. 03730

03105 **Jacob, Arthur Frank.** Delta facies of the Green River Formation (Eocene), Carbon and Duchesne Counties, Utah [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4661B-4662B, 1970.

03586 **Jacobson, Russell.** The Gilmore City crinoid fauna: Earth Sci., v. 23, no. 5, p. 228-233, illus., 1970.

The crinoids at Gilmore City, Iowa, are found in the Mississippian Gilmore City Formation, which is divided into four paleontologic zones. Crinoid colonies occur in green marl partings in limestone, or in shaly lenses. Methods of preparation and identifying specimens are described; known species are listed and illustrated. — ESL

03471 **Jacoby, W. R.** Gravity diagrams for thickness determination of exposed rock bodies: Geophysics, v. 35, no. 3, p. 471-475, illus., 1970.

Sets of diagrams of the normalized peak gravity effect of exposed rock bodies can be used to determine the depth to which the bodies extend. The advantages of the method are: (1) straight-forward and easy application, (2) clear display of the uncertainty of the result, and (3) applicability to any shape rock bodies. — Author's abstract

03332 **Jaeger, Charles.** Engineering and rock mechanics, Pt. 1: Water Power, v. 22, nos. 5-6, p. 203-209, illus., tables, 1970.

This is the first of two articles in which the construction of a number of large dams is examined to show how rock mechanics is used to solve civil-engineering problems. The limitations of current knowledge and techniques are revealed, and some lines for future research discussed. Case histories given include the Morrow Point dam site, Colorado, the Dez dam project in Iran, and the Malpasset dam failure in France. — ESL

03096 **Jagannath, Banad Nandiswar.** Certain mechanical properties of gyratory compacted kaolin clay [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4609B, 1970.

03613 **James, Gerard W.** Comment on a paper "Carbonate facies and paleogeography of the Blackjack Creek Formation (Pennsylvanian), Missouri" [by W. J. Neal, 1969]: Jour. Sed. Petrology, v. 40, no. 2, p. 765-767, 1970.

For original paper, *see* ibid., v. 39, no. 1, p. 34-48, 1969; Abs. North American Geology, October 1969.

03603 **Jansa, Lubomir F.; Carozzi, Albert V.** Exotic pebbles in La Salle Limestone (Upper Pennsylvanian), La Salle, Illinois: Jour. Sed. Petrology, v. 40, no. 2, p. 688-694, illus., 1970.

Newly-discovered exotic pebbles in La Salle Limestone include: 20 percent low-grade metamorphic rocks, 10 percent sedimentary rocks, and 10 percent monomineralic grains. Their distribution is bimodal associating gravel fraction to a clay fraction. A wide source area of Precambrian rocks is indicated, the nearest one being in Wisconsin, 250 miles northeastward. An earlier fluvial transportation interval must be assumed, probably in relation to a change of base-level during typical regressive conditions of a cyclothem. The final distribution in the carbonate basin is assumed to have been as a submarine mudflow which traveled along a narrow path for about 10 to 20 miles, possibly triggered by storms or mild earthquakes. The former interpretation of the transportation by ice-rafing is rejected. — HRC

03149 **Jeletzky, J. A.** Some salient features of early Mesozoic history of Insular Tectonic Belt, western British Columbia: Canada Geol. Survey Paper 69-14, 26 p., illus., 1970.

Ubiquitous thick submarine Karmutsen volcanics and basal Quatsino limestones in this seaward belt indicate lateral extension of a subsiding Early Triassic basin. The upper Quatsino, restricted to the central zone, with Norian argillaceous clastics to the southwest and argillites northeast, was gradually narrowed, then fragmented by late Norian uplift into Buttle Lake area and Queen Charlotte Islands segments, introducing a complicated facies in western Vancouver Island. The latest Triassic orogeny with concurrent volcanic outbursts did not affect the eastern marine region. Early Jurassic deposition left 12,000 to 15,000 feet of volcanics and interbedded marine sediments in the tectonically active zone, only 2,000 to 5,000 feet of argillites and limestones in the quiescent zone. Middle Jurassic orogeny and batholithic Coast Intrusions transformed all into tectonic land, and caused migration of Yakoun volcanics into the earlier quiescent zone. — GDC

03663 **Jenkins, Farish A., Jr.** Cynodont postcranial anatomy and the "prototherian" level of mammalian organization: Evolution, v. 24, no. 1, p. 230-252, illus., 1970.

The biological level of organization of mammalian ancestors in Late Triassic time is evaluated here by: reviewing the functional implications of the postcranial skeleton of cynodonts (Permo-Triassic mammal-like reptiles); comparing salient physiological and anatomical features of living monotremes (prototherians) with those of therians. Cynodonts had a number of postcranial skeletal characters that were incipiently mammalian in function; monotremes have essentially reptilian, intermediate, essentially therian, and uniquely specialized features, and thus should not be taken as a model of biological intermediacy between reptiles and therians. But monotremes and therians share so many basic physiological and anatomical features that parallel development of all these seems unlikely; rather, they both must have inherited from their common, probably Late Triassic, ancestor a fundamentally mammalian biological system. — VMJ

Johnson, C. G. *See* Housner, G. W. 03031

03212 **Johnson, Gerald W.** Plowshare at the crossroads: Bull. Atomic Scientists, v. 26, no. 6, p. 83-91, illus., 1970.

The research and development effort of the Plowshare Program over the past decade was largely devoted to excavation techniques and problems of slope stability and radioactive fallout, related to the possible excavation of an isthmian canal in Panama. Much knowledge was gained from the development of a cratering theory of calculating crater dimensions and from actual nuclear cratering experiments carried out in basalt and desert alluvium. Fallout, although still a problem, has been greatly reduced and ecological safeguards have been imposed. Potential industrial uses of nonventing deeply-buried nuclear explosions include: recovery of copper, water-resource conservation and control, petroleum and natural gas storage, stimulation and recovery. Lately chemical explosives have been found to be generally competitive with nuclear explosives up to a few kilotons, both economically, from a safety aspect, and in other applications. — EH

03598 **Jones, Michael L.; Dennison, John M.** Oriented fossils as paleocurrent indicators in Paleozoic lutites of southern Appalachians: Jour. Sed. Petrology, v. 40, no. 2, p. 642-649, illus., 1970.

Preferred orientation (from 13,000 fossils) was detected by vector mean and Rayleigh tests, and supplemented by chi-square calculations. Measurement of hundreds of individuals per sample yielded highly significant orientations which could be related to inferred paleoslope directions. Included were graptolites, brachiopods, criccoconarids, ostracods, gastropods, and *Tasmanites*. A single section of Ordovician Athens Shale in Alabama was studied in detail to evaluate vertical consistency of paleocurrent information from graptolites (transport direction due west). On a regional pattern, this agreed with the westerly transport directions for Athens muds at Centerville and Kingsport, Tennessee. Regional consistency of a single stratigraphic horizon was demonstrated for the basal portion of the Chattanooga Shale at Clinch Mountain, Tennessee. A uniform direction of N 75° W was obtained from four localities. — *from* Authors' abstract

Jones, Thomas A. *See* Krumbein, W. C. 03600

03106 **Jones, Thomas Allen.** A comparison of the estimators of sediment grain-size distributions [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4662B, 1970.

03296 **Jongejan, A.; Wilkins, A. L.** Phase equilibrium studies in the system CaO-Nb_2O_5-TiO_2: Jour. Less-Common Metals, v. 21, no. 3, p. 225-253, illus., tables, 1970.

A mineralogical investigation of niobium ore from Oka, Quebec, disclosed the close genetic relation between pyrochlore and perovskite. The molar content of titania in the perovskite is less than half that of niobia, so that it should be considered a calcium niobate rather than a titanate, and its X-ray diffraction powder pattern resembles that of a calcium niobate having a perovskite-type pattern. Because of these properties, phase relations in the system CaO-Nb_2O_5-TiO_2 have been studied to determine the possible existence of solid solutions. Liquidus fields of three ternary compounds have been outlined, in addition to those of the binary compounds. Perovskite did not form solid solutions with any calcium niobates notwithstanding that the compound $4(CaO)(Nb_2O_5)$, and probably other niobates, have a perovskite-type structure. — ESL

03440 **Journaux, André.** La plaine du gel éternel en Alaska [The permafrost plain of Alaska (with English, German and Russian abs.)]: Sci. Prog. Découverte, no. 3422, p. 37-43, illus., 1970.

Under the auspices of the Polar Continental Shelf Project, various periglacial features of the Arctic coastal plain of Alaska, and of the Yukon Territory and some islands of the Canadian Arctic were studied. Interstitial ice, ice lenses, wedges, polygons and pingos, and various types of lakes found in permafrost areas are described; rock boils and rock flows are treated briefly. — EH

03721 **Judd, James B.; Smith, William C.; Pilkey, Orrin H.** The environmental significance of iron-stained quartz grains on the southeastern United States Atlantic shelf: Marine Geology, v. 8, no. 5, p. 355-362, illus., 1970.

About 1000 samples show significant differences in percentages of iron-stained quartz grains in two sand size fractions in shelf and beach and river sands. More iron-stained quartz is found in Piedmont-draining rivers than in Coastal Plain-draining rivers. The iron-stained quartz on the shelf may be due in large part to the Pleistocene river contributions rather than to subaerial weathering of shelf sediments, as indicated by shelf abundance anomalies related to river mouths. These same shelf anomalies are evidence of lack of extensive lateral transportation of sediment on the shelf. Abrasion is apparently not effective in removing the iron coating from the quartz grains in any environment, even the beach environment. — *from* Authors' abstract

Kachadoorian, Reuben. *See* Sainsbury, C. L. 03334

03263 **Kadirgamathaiyah, Sinnathamby.** Role of aluminum and iron hydroxy compounds in the adsorption of organic matter by a montmorillonite clay [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 4873B, 1970.

03509 **Kaila, K. L.** Decay rate of P-wave amplitudes from nuclear explosions and the magnitude relations in the epicentral distance range 1° to 98°: Seismol. Soc. America Bull., v. 60, no. 2, p. 447-460, illus., 1970.

Study of decay rate with epicentral distance of P-wave amplitudes from nuclear explosions in the distance range 1° to 98° reveals that amplitudes are most appropriately represented by six discontinuous curves. Magnitude relations were worked out corresponding to these which yield consistent magnitudes for nuclear explosions as well as earthquakes independent of epicentral distance over the entire 1°-98° distance range. Magnitude values are shifted towards the higher side by 0.22 magnitude unit (at $M = 4.5$) as compared to those predicted by the Gutenberg-Richter method. Magnitudes evaluated for Logan, Blanca, and Salmon explosions using the new relations agree fairly well with published magnitudes for these events determined by others using the Gutenberg-Richter method. These amplitude decay curves show reasonable correspondence between starting points of amplitude curves and distances where deeply refracted phases from mantle velocity discontinuities start appearing as first arrivals on the surface. — *from* Author's abstract

Kaiman, S. *See* Harris, D. C. 03497

03451 **Kamp, J. W.** The cavernicolous Grylloblattodea of the western United States [with French abs.]: Annales Spéléologie, v. 25, pt. 1, p. 223-230, illus., 1970.

Insects of the genus *Grylloblatta* are primitive wingless orthopterans with low-temperature and high-humidity requirements, restricted to alpine-subalpine zones where they live under rocks adjacent to meltwater runoff or at margins of permanent snowfields. In western North America they are limited to Pleistocene glaciated areas; one group of species occurs in the Sierra Nevada-Cascade Ranges of California, Oregon, and Washington, a second group in the Rocky Mountains of Wyoming, Montana, and western Canada. Three species and eight unnamed populations, all in the first group, also inhabit ice caves in the Great Basin-Columbia lavas. It is suggested that most cave populations date from late Pleistocene or early postglacial, 13,600-8,000 years B.P.; a few may date from Medithermal time, 3,000 years B.P. or later, when a cooler, moister climate succeeded the warm, dry hypsithermal period. — VMJ

Kaplan, I. R. *See* Smith, J. W. 03638

03519 **Karaoguz, Dogu; Helander, D. P.; Kemp, M. K.** An experimental study of Redox Logging: Log Analyst, v. 11, no. 3, p. 8-16, illus., tables, 1970.

SP and differential potential (SP-Redox Potential) was measured on 17 sandstone core samples from different fields; the influence of specific minerals (pyrite, lignite, sulfur) was studied by artificially adding a mineral in increasing amounts to a previ-

ously measured clean sandstone sample; laboratory apparatus simulated borehole conditions. Sandstone, shale, and mud sections were combined in a closed system in which an SP current flow was developed and measured; an oxidizing agent was added to the mud in controlled amounts. Results indicate: different kinds of sandstone formations may show differential potentials having different magnitudes; the differential potential of a sandstone-shale-mud system is directly proportional to the SP; when mineral contents are increased by artificially adding specific minerals, the differential potential changes (more rapidly with pyrite than lignite); and rate of change of the differential potential is a function of the mineral content in the sandstone. — *from* Authors' abstract

Karasik, A. M. *See* Grachev, A. F. 03449

03107 **Karp, Edwin.** Aspects of strain history in experimental rock deformation [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4662B-4663B, 1970.

03495 **Karup-Möller, S.** Gustavite, a new sulphosalt mineral from Greenland: Canadian Mineralogist, v. 10, pt. 2, p. 173-190, illus., tables, 1970.

Two new sulphosalt minerals found in the cryolite deposit at Ivigtut, southwest Greenland are described as gustavite and phase X. Phase X has exsolved from gustavite and occurs in this mineral as submicroscopic blebs. The two phases show parallel crystallographic alignment. They have orthorhombic symmetry, *Bbmm*, $Bb2_1m$ or *Bbm*2, identical *a* and *c* cell dimensions (13.548 ± 0.033 A and 4.105 ± 0.013 A respectively) but slightly different *b* dimensions (19.440 ± 0.026 A and 20.0 A). Electron microprobe analyses agree best with the compositions: gustavite = $Bi_{11}Pb_3Ag_3S_{24}$, phase X = $Bi_{10}Pb_7Ag_2S_{24}$. Physical and optical data of the two phases are given. The two phases may form members of a solid solution series between Pb_3Bi_2S (lillianite) and $AgPbBi_3S_6$. Similar cell dimensions and space groups of gustavite, phase X and andorite ($AgPbSb_3S_6$) also indicate a solid solutions series. — Author's abstract

03501 **Katz, M. B.** Notes on the mineralogy and coexisting pyroxenes from the granulites of Mont Tremblant Park, Quebec: Canadian Mineralogist, v. 10, pt. 2, p. 247-251, table, 1970.

The minerals of the granulites are distinctive of the granulite facies. Two analyses of coexisting pyroxene pairs from rocks associated with the granulites are presented from an interlayered pyriclasite and an intrusive quartz mangerite. The analyses of the pyriclasite indicate that the granulites formed under conditions of approximately 600-700°C and up to 10 kbs in pressure and that of the mineralogy of the quartz mangerite confirms its magmatic origin — Author's abstract

03709 **Katz, Michael B.** Banded gneisses — Thickness distribution of layers and their lithologic transitions: Lithos, v. 3, no. 1, p. 1-12, illus., tables, 1970.

Measurements on sets of beds of sedimentary rocks have shown that the distribution of bed thickness tends to be log-normal. Similar studies on the banding and on compositional layering in Precambrian highgrade metamorphic banded gneisses of Quebec, Canada, the highlands of Ceylon, and Norway reveal a similar statistical distribution. As was shown in sedimentary rocks, there appears to be a dependency among layers of certain lithologies. The apparent log-normal distribution of bed thickness found in sedimentary rocks and gneisses, and their lithologic relationships are discussed in terms of a criterion to determine the origin of metamorphic layering. — Author's abstract

03418 **Kaula, William M.** Earth's gravity field, relation to global tectonics: Science, v. 169, no. 3949, p. 982-985, illus., table, 1970.

An improved solution for the gravity field shows ocean rises, as well as trench and island arc, as mass excesses. Ocean basins, areas of recent glaciation, and the Asian portion of the Alpide belt are mass deficiencies. Most features appear interpretable as varying behavior of the lithosphere in response to asthenospheric flow. — Author's abstract

03705 **Keary, R.** Coastal climate and shelf-bottom sediments — A comment [on a paper by M. O. Hayes, 1967]: Marine Geology, v. 8, no. 5, p. 363-365, 1970.

For the original paper, *see* ibid., v. 5, no. 2, p. 111-132; Abs. North American Geology, January 1968.

03082 **Keeble, A. B.** The mode of origin and depositional history of kames southwest of Edmonton: Albertan Geographer, no. 6, p. 33-44, illus., tables, 1970.

A general reconnaissance was made of a kame area, southwest of Edmonton, Alberta, also a detailed study of two sand pits located on the crest of the kame, at which vertical logs were selected, depositional sequences taken, and paleocurrent directions recorded. It is concluded that the ridge is an elongate, subaerial kame, laid down by a glacial meltwater stream. Depositional chronology of the kame is given. — EH

Keen, M. J. *See* Beaumont, C. 03408

03330 **Keeney, Dennis R.; Konrad, John G.; Chesters, Gordon.** Nitrogen distribution in some Wisconsin lake sediments: Water Pollution Control Federation Jour., v. 42, no. 3, pt. 1, p. 411-417, tables, 1970.

Nitrogen distribution analyses of sediment samples from 13 Wisconsin lakes differing in trophic level and water hardness were conducted. About 98 percent of the sediment nitrogen was in the organic form, the remainder being present as clay-fixed and exchangeable ammonium. Of the organic nitrogen, about 82 percent was soluble in hot 6 N HCl. Hydrolyzable ammonium, hexosamine, amino acid, and hydroxy amino acid-nitrogen averaged 15, 4, 38, and 7 percent, respectively, of the sediment organic nitrogen. With increasing fertility levels, hexosamine-nitrogen tended to decrease and amino acid-nitrogen to increase, indicating a greater microbial turnover of organic nitrogen in oligotrophic than in eutrophic lake sediments. — Authors' abstract

03752 **Kehle, Ralph O.** Analysis of gravity sliding and orogenic translation: Geol. Soc. America Bull., v. 81, no. 6, p. 1641-1663, illus., table, 1970.

Gravity sliding, major thrusting, and displacement of large crustal plates are accomplished because strata with the lowest viscosity in a rock sequence readily deform by simple shear flow when subjected to loading. These deformating strata are called *decollement* zones. Strata above are transported without deformation, provided their viscosity is one or more orders of magnitude larger than that of the *decollement* zone. Shear stresses acting at the base of strata in *decollement* zones most likely represent the operative mechanism. Speed of sliding and ease of transport increase with increasing *decollement* zone thickness, dip, and depth of burial, and decrease with increasing viscosity. [Structures within and above the *decollement* zone are described.] Velocity profiles for simple shear portray general mode of deformation and permit study of transport in specific geologic settings. — *from* Author's abstract

Keir, D. L. *See* Hamilton, E. L. 03725

Kemp, M. K. *See* Karaoguz, Dogu. 03519

Kennedy, V. C. *See* Malcolm, Ronald L. 03331

03264 **Kepper, John Charles.** Stratigraphy and petrology of a Middle and Upper Cambrian interval in the Great Basin [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5102B, 1970.

03739 **Keulegan, Garbis H.; Harrison, John.** Tsunami refraction diagrams by digital computer: Am. Soc. Civil Engineers Proc., v. 96, paper 7261, Jour. Waterways and Harbors Div., no. WW 2, p. 219-233, illus., tables, 1970.

Important wave parameters for tsunami model studies are wave height, period, and orientation. The first two can be determined by marigraphic measurements or by visual observations; however, wave-front orientation, an important variable in con-

struction and operation of a hydraulic model, has never been accurately observed at the problem site (Crescent City, Calif.). A digital computer program was written to plot wave rays from tsunami sources to obtain tsunami-front orientations. The refraction diagrams are checked by comparing computed and actual arrival times of initial wave fronts. The latter were obtained from recording tide stations. Initial wave-front orientations near the earthquake epicenter are either assumed or taken from the literature. The computer program has been successfully tested against a closed form solution for the refraction around a selected island shape. The technique also compensates for the distorted picture of the earth's surface as presented on a Mercator projection. — *from* ASCE abstract

Kiefer, Fred W. *See* Seed, H. Bolton. 03635

03207 **Kiilsgaard, Thor H.; Freeman, Val L.; Coffman, Joseph S.** Mineral resources of the Sawtooth Primitive Area, Idaho: U.S. Geol. Survey Bull. 1319-D, p. D1-D174, illus., tables, geol. map, 1970.

The Sawtooth Range is an uplifted block, bounded on the NE and SW by major faults, and sculptured by glaciation and other erosion. The area is underlain by granitic rocks of the Idaho and Sawtooth batholiths, metamorphic rocks crop out in the northern part, and all rocks are intruded by swarms of Tertiary dikes. The mineral survey consisted of reconnaissance geologic mapping, extensive sampling, studies of known mineral occurrences or areas favorable for deposits, and an aeromagnetic survey. The area is near or contiguous to six mining districts, none of which produces ore; Little Queens mine in the primitive area has reportedly produced gold-silver ore. Absence of minable deposits at the surface of hydrothermally altered and mineralized rocks does not preclude possible ore bodies at depth; possibilities may exist for molybdenum, placer deposits, uranium, beryllium, and other metals, but present evidence does not indicate they are commercially valuable. — *from* Authors' abstract

03184 **Kim, Stephen M.** Illinois State Geological Survey radiocarbon dates II: Radiocarbon, v. 12, no. 2, p. 503-508, 1970.

King, C. A. M. *See* McCullagh, M. J. 03201

03510 **King, Chi-Yu.** Particle motion along a kinematic fault model: Seismol. Soc. America Bull., v. 60, no. 2, p. 491-501, illus., 1970.

Particle motion was examined along the following fault model: the fault plane is a rectangle so elongated that differences in particle motion in the shorter dimension can be neglected and rupture, once initiated, propagates only in the longitudinal direction(s) at constant speed; distribution of particle displacement along the ruptured fault maintains the same sinusoidal shape at different times until finally all particles stop simultaneously. The pattern of particle motion depends on whether rupture propagates unilaterally or bilaterally. For bilateral, particle displacement and velocity are nearly a finite ramp and a box-car function of time, respectively. Maximum particle velocity is the same everywhere along the final ruptured segment, but average velocity is slightly higher for particles closer to the ends. For unilateral, particle velocity is approximately an impulse function of time for particles near the starting edge and gradually becomes a box-car function for particles near the ending edge of rupture. Maximum velocity is the same for all particles along the segment, but average velocity is considerably higher for particles closer to the ending edge. — *from* Author's abstract

03434 **King, Rubert U.** (compiler). Molybdenum in the United States, exclusive of Alaska and Hawaii: U.S. Geol. Survey Mineral Inv. Resource Map MR-55, scale 1:3,168,000, separate text, 1970.

The map shows the principal deposits and many minor occurrences of molybdenum in the conterminous United States; six types are distinguished by shapes of symbols used and three size categories indicate relative importance of deposits. Deposits or localities are numbered consecutively by States and are identified in the locality in-

dex; at least one reference is given for each locality if reports concerning the area are published. – MCM

03208 **Kingston, Gary A.; Carrillo, Fred V.; Gray, Jerry J.; McIlroy, Paul.** Availability of U.S. primary nickel resources: U.S. Bur. Mines Inf. Circ. 8469, 57 p., illus., tables, 1970.

Nickel resources in the United States and Puerto Rico available at prices up to 6.36 dollars per pound total about 5.9 billion pounds. Sulfide ore in 16 areas, in most of which copper is also present, contains about 1.76 million pounds Ni. Another 4.13 billion pounds is in oxide ore (nickeliferous silicate laterite and nickeliferous iron laterite) in 24 areas. Study of production costs indicate that a little more than 4 billion pounds, 96.7 percent, of the recoverable nickel could be extracted at a cost of 3.64 dollars per pound or less. Resources and detailed cost data are tabulated by areas. — APB

03222 **Kirichenko, L. V.** Radon exhalation from vast areas according to vertical distribution of its short-lived decay products: Jour. Geophys. Research, v. 75, no. 18, p. 3639-3649, illus., tables, 1970.

The use of natural radioactivity in the investigation of mixing and transport processes in the atmosphere is impossible without allowing for radon influx from vast surfaces on the Earth. An estimate of the effective radon flux from areas with nonuniform emanation is considered. The technique consists of calculating the total amount of natural radioactive products through the entire atmosphere per unit of ground surface. A vertical profile of the α-active short-lived products of radon has been determined by sounding the atmosphere with equipment installed in aircraft. The possibilities of the technique are analyzed. — Author's abstract

Kirklin, Richard H. *See* Shopland, Robert C. 03354

03472 **Kleinkopf, M. Dean; Peterson, Donald L.; Gott, Garland.** Geophysical studies of the Cripple Creek mining district, Colorado: Geophysics, v. 35, no. 3, p. 490-500, illus., 1970.

Integrated geophysical, geochemical, and geologic interpretations expand knowledge of localization of ore deposits in Cripple Creek district, Colorado. Principal gold deposits occur in a Tertiary volcanic subsidence basin within Precambrian granite, gneiss, and schist, and filled with volcanic breccia and intruded by dikes and irregular masses. The volcanic complex gives rise to a broad 10 mgal gravity minimum anomaly upon which are superimposed local minima related to deep mineralized fissure zones. A negative magnetic anomaly over the subsidence basin probably reflects degree of alteration of subsurface rocks. Two local closed magnetic lows may represent highly altered volcanic centers in the basin bottom. Gravity and magnetic anomalies of the basin correlate geographically with positive geochemical anomalies for gold, silver, and tellurium. Just east of the basin, a prominent negative magnetic anomaly and a corresponding gravity low may represent an altered zone in the granite subsurface. — *from* Authors' abstract

03319 **Kliewer, Gene.** Challenger Leg 10 finds gas in Gulf of Mexico: World Oil, v. 171, no. 2, p. 43-45, illus., 1970.

Possibly significant discoveries into the origin of hydrocarbons were made from the 3,000 feet of core recovered in and around the Florida Straits, Campeche Bank, and Sigsbee Plain. Natural gas was encountered in deep basin holes and there are strong indications that some reflectors are salt masses, although no salt was actually cored. — Author's abstract

Klingeman, Peter C. *See* Roberts, Michael C. 03620

03023 **Klusman, Ronald William.** Electron microprobe analysis of feldspars [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5102B-5103B, 1970.

Knauer, George A. *See* Wallick, Edward I. 03423

03679 **Knopoff, L.; Mal, A. K.; Alsop, L. E.; Phinney, R. A.** A property of long-period Love waves: Jour. Geophys. Research, v. 75, no. 20, p. 4084-4086, illus., 1970.

This note discusses a property of long-period Love waves in a medium with layers of varying thickness. Attention is confined to a homogeneous overlying layer, the thickness of which changes within a distance of the order of a wavelength or less. The eigenfunctions for the two quarter spaces are shown to be strong functions of the layer thickness at all frequencies including zero. — DBV

03624 **Koerner, Robert M.** Effect of particle characteristics on soil strength: Am. Soc. Civil Engineers Proc., v. 96, paper 7393, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1221-1234, illus., tables, 1970.

The effects of varying particle characteristics on the strength behavior of cohesionless soils are experimentally evaluated. Soil strength is measured on the basis of the angle of shearing resistance with dilatation removed. These cohesionless soils were laboratory prepared from single minerals under closely controlled conditions. It is shown that soil strength increases with increasing angularity and decreasing sphericity. There is an increase in strength with decreasing effective size, particularly with sizes less than 0.06 mm. At a given relative density or void ratio the influence of different soil gradations has little effect on soil strength. An approximate relationship for the corrected angle of shearing resistance is formulated. — ASCE abstract

03630 **Koerner, Robert M.** Behavior of single mineral soils in triaxial shear: Am. Soc. Civil Engineers Proc., v. 96, paper 7432, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1373-1390, illus., tables, 1970.

Quartz, feldspar, calcite, chlorite and mica soil samples are laboratory-prepared, characterized on the basis of their physical properties and tested in triaxial shear. Saturated and air-equilibrated dry tests are performed on all samples. The drained triaxial test results are modified to account for dilatation and compared with values obtained from undrained-pore pressure tests. The analysis due to Ladanyi shows good agreement for such a dilatation correction. These values are then mineralogically compared: on the basis of relative density at failure; by Rowe's stress-dilatancy theory; and on the basis of physical friction. The flaky soil samples consisting of chlorite and mica behave quite differently from other soil types. Previously published values of physical friction as obtained from direct shear type tests seem questionable. Quartz soils show slightly greater strength when saturated while all other soils show greater dry strength. — ASCE abstract

03265 **Kolodny, Yehoshua.** Studies in geochemistry of uranium and phosphorites [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5103B, 1970.

03116 **Komar, Paul Douglas.** The longshore transport of sand on beaches [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4729B, 1970.

Konrad, John G. *See* Keeney, Dennis R. 03330

Koto, Kichiro. *See* Morimoto, Nobuo. 03170

03174 **Kreidler, Eric R.; Hummel, F. A.** The crystal chemistry of apatite — Structure fields of fluor- and chlorapatite: Am. Mineralogist, v. 55, nos. 1-2, p. 170-184, illus., tables, 1970.

A comparative study of the crystal chemistry of synthetic fluor- and chlorapatites was made. The common apatites prepared may be represented by the general formula $A_{10}(XO_4Z_2$, where A=Cd, Ca, Sr, Pb, or Ba; X=P, As, or V; and Z=F or Cl. Almost all combinations formed apatites, and some unusual apatites were confirmed. The structure fields of fluorapatite and chlorapatite were determined, and from them the size limitations on ions capable of totally occupying the calcium and phosphorous positions were deduced. The lattice parameters of about 35 apatites were determined, some for the first time. — *from* Authors' abstract

03600 **Krumbein, W. C.; Jones, Thomas A.** The influence of areal trends on correlations between sedimentary properties: Jour. Sed. Petrology, v. 40, no. 2, p. 656-665, illus., tables, 1970.

A shift of emphasis for consideration of correlation coefficients (which are not additive) to covariance sums of crossproducts, which are, affords additional opportunities for analyzing the contributions of two or more sources of covariation in the total observed correlation between sedimentary attributes. In this approach trend surface analysis plays an important role in partitioning the crossproduct sum. A statistical model is presented for this purpose, and some sources of covariation in beach foreshore properties are examined in part by simulation studies of areal patterns of variation and the population densities of mapped variables. — *from* Authors' abstract

Kuba, Edward M. *See* Wiegel, Robert L. 03719

Kulm, L. D. *See* Griggs, G. B. 03402

03767 **Kuno, Hisashi; Aoki, Ken-Ichiro.** Chemistry of ultramafic nodules and their bearing on the origin of basaltic magmas, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 273-301, illus., tables, 1970.

Bulk compositions of lherzolite nodules in basaltic rocks range widely in MgO/ΣFeO; with increase of this ratio, lower melting oxide components increase and higher melting components decrease. Websterite nodules associated with lherzolite show similar variation in oxide components, but differ in content of some oxides if rocks of the same MgO/ΣFeO are compared. Major feature of lherzolite variation can be explained as due to different degrees of partial melting of primordial material. Magmas thus generated also vary in composition from oceanite to olivine tholeiite. Lherzolite variation could also be explained as due to successive crystal settling in a series of magmas from oceanite to olivine tholeiite; partial melting is a more likely process. Websterite variation is probably caused by crystal settling in basaltic magmas. The primordial material has a composition similar to the silicate phase of the average bronzite chondrite. — *from* Authors' abstract

03522 **Kuo, John T.; Ottaviani, Mario; Singh, Shri K.** Reply by authors to Dr. Thyssen-Bornemisza's discussion [of "Variations of vertical gravity gradient in New York City and Alpine, New Jersey" (1969)]: Geophysics, v. 35, no. 3, p. 522, 1970.

For the paper under discussion, *see* ibid., v. 34, no. 2, p. 235-248, 1969; Abs. North American Geology for November 1969.

03164 **Kvenvolden, Keith A.; Peterson, Etta; Brown, Frederick S.** Racemization of amino acids in sediments from Saanich Inlet, British Columbia: Science, v. 169, no. 3950, p. 1079-1082, illus., table, 1970.

In sediments spanning the last 9000 years from Saanich Inlet L enantiometers of amino acids are most abundant, but the percentages of D enantiometers increase with age, apparently because of partial racemization. Of the amino acids measured, glutamic acid and alanine show the greatest degree of racemization; leucine, isoleucine, and valine show the least. — Authors' abstract

03266 **Kwon, Hyuck Jae.** Source of barrier island sediments, northern Gulf Coast [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5103B-5104B, 1970.

03690 **Lachenbruch, Arthur H.** Crustal temperature and heat production — Implications of the linear heat-flow relation: Jour. Geophys. Research, v. 75, no. 17, p. 3291-3300, illus., 1970.

The linear relation between surface heat flow and heat production in plutons can be explained in terms of an exponential decrease of heat production with depth. Recent heat-flow results indicate that the decrement D of the exponential function varies little from one province to another, which suggests that D is a general geochemical pro-

perty of the crust beneath plutons. The outer layer of variable heat production is a zone of partial melting in which the heat-producing elements were redistributed exponentially during the plutonic process. This zone typically includes a substantial portion of the crust. Upward concentration of crustal heat production and heat flow from much of the continental mantle are greater than generally supposed. Crustal temperatures beneath plutons are estimated. — DBV

Ladanyi, B. *See* Hoyaux, B. 03765

03108 **Lafon, Guy Michel.** Some quantitative aspects of the chemical evolution of the oceans [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4663B, 1970.

LaFountain, L. *See* Larson, E. E. 03362

Lahiri, A. *See* Rao, S. V. L. N. 03087

03211 **Lambert, A.** The response of the Earth to loading by the ocean tides around Nova Scotia: Royal Astron. Soc. Geophys. Jour., v. 19, no. 5, p. 449-477, illus., tables, 1970.

The tidal loading effects on gravity and tilt caused by the large amplitude tides in the Bay of Fundy have been separated from the effects of the tides in the Gulf of St. Lawrence and North Atlantic Ocean. The isolated Bay of Fundy tilt has been compared with experimental and theoretical studies. The results suggest that a simple two-layer elastic model having rigidities compatible with seismic models for the area would fit the observations. Tilts due to tides in the Gulf of St. Lawrence and North Atlantic do not fit any reasonable laterally homogeneous elastic models. Results of gravity observations on the whole confirm the tilt results. It is concluded that the effects of ocean tide loading on gravity and tilt measurements are dependent upon the tectonic structure of the surrounding area. The structural effect is especially important where there is tidal loading on extensive continental areas such as the Gulf of St. Lawrence. — DBV

03412 **Lambert, Ian B.; Wyllie, Peter J.** Low-velocity zone of the Earth's mantle — Incipient melting caused by water: Science, v. 169, no. 3947, p. 764-766, illus., 1970.

Experimental phase diagrams for the systems gabbro-water and peridotite-water indicate that, if there is any water in the upper mantle, then traces of hydrous interstitial silicate magma will be produced at depths corresponding to the beginning of the low-velocity zone. This explanation for the zone is more satisfactory than others proposed. — Authors' abstract

03718 **Langfelder, Leonard J.; Stafford, Donald B.; Amein, Michael.** Coastal erosion in North Carolina: Am. Soc. Civil Engineers Proc., v. 96, paper 7306, Jour. Waterways and Harbors Div., no. WW 2, p. 531-545, illus., tables, 1970.

Aerial photography and wave refraction procedures were used to study coastal erosion along the entire 330 miles of the North Carolina coast. The aerial photography method made use of measurements made at 1,400 selected stable measuring points on photographs that were taken as early as 1938. The wave refraction method made use of a computer program to obtain the refracted directions of selected incoming waves. The longshore wave energy was then converted to littoral drift through use of an empirical equation. The results of both methods indicate the general trend in erosion. Erosion caused by major storms is a significant portion of the total erosion. This storm-induced erosion is included in the results of the aerial photography method but has only a small influence on the results of the wave refraction method. — ASCE abstract

LaRochelle, P. *See* Tavenas, F. 03756

Larson, A. L. *See* Norvitch, R. F. 03750

03362 **Larson, E. E.; LaFountain, L.** Timing of the breakup of the continents around the Atlantic as determined by paleomagnetism: Earth and Planetary Sci. Letters, v. 8, no. 5, p. 341-351, illus., table, 1970.

Evaluation of the reconstruction of the predrift configuration of the continents around the Atlantic Ocean given by Bullard et al (1965) using paleomagnetic data obtained essentially only from well-dated thermally or a.c. demagnetized rock sequences indicates that during the Carboniferous, Permian, and much of the Triassic the continents were contiguous or nearly so. About 200 m.y. ago the continents began to drift apart. By middle to late Cretaceous time the South Atlantic was about 40 percent open, whereas the North Atlantic (north of 40°) was nearly entirely open. Seemingly, the opening of the Atlantic proceeded relatively uniformly over its entire length during the first 100 m.y. of its existence, but in the last 100 m.y. the South Atlantic has been opening at a rate faster than its northern counterpart. The age of the Atlantic north of 40° from the paleomagnetic evaluation is in disagreement with some conclusions reached from consideration of linear magnetic anomalies on the ocean floor. — *from* Authors' abstract

03651 **Laul, J. C.; Case, D. R.; Wechter, M.; Schmidt-Bleek, F.; Lipschutz, M. E.** An activation analysis technique for determining groups of trace elements in rocks and chondrites: Jour. Radioanal. Chemistry, v. 4, no. 2, p. 241-264, illus., tables, 1970.

A thermal neutron activation analysis technique has been developed for the analysis of terrestrial rocks and stony meteorites for trace elements. The main emphasis of the method is directed toward minimizing chemical procedures and maximizing the use of Ge(Li) gamma spectroscopy and computer data reduction. The validity of the technique is demonstrated by presenting data obtained for synthetic samples, U.S.G.S. Standard Rocks and three ordinary chondrite meteorites for the following elements: As, Au, Co, Cs, Ga, Ge, Hg, Mo, Os, Re, Sb, Sc, Se, Te, and Zn. — Authors' abstract

03020 **Laverdière, Camille.** Description d'une coupe (Anse de Roberval, Québec) pour servir à l'étude des dépôts du golfe de Laflamme [Description of a section (Roberval Cove, Quebec) made to study the gulf of Laflamme deposits (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 330-333, illus., table, 1970.

A section, made in deposits at Roberval Cove, Quebec, is described, and the succession from glacial margin to littoral deposition is given. — EH

03128 **Laverdière, Camille; Bernard, Claude.** Bibliographie annotée sur les broutures glaciaires – An annotated bibliography on glacial chattermarks [text in French and English]: Rev. Géographie Montréal, v. 24, no. 1, p. 79-89, 1970.

This bibliography (annotated in French) illustrates the widely divergent use of the term "glacial chattermark" in both English and French writings to describe small-scale features of glacial erosion. The bibliography, limited almost exclusively to English and French publications, is not intended to be complete, but will indicate the scope of the field. — MCM

03239 **Laverdière, Camille; Lengellé, Jean-G.** Trains de broutures glaciaires au Témiscamingue, Quebec [Glacial chattermark trains at Temiskaming, Quebec (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 327-329, illus., 1970.

The authors describe concave chattermark trains found on the Lake Temiskaming (Témiscamingue) basin near Ville-Marie, Quebec, and discuss the origin of these glacial features. – EH

03186 **Lawn, Barbara.** University of Pennsylvania radiocarbon dates XIII: Radiocarbon, v. 12, no. 2, p. 577-589, 1970.

03109 **Lawrence, Edmond Francis.** Geological and geophysical investigations of the mineral deposits of the Calico area, Mineral County, Nevada [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4663B, 1970.

03215 **Lay, E. P.** Descent to the deep: Oceans, v. 3, no. 2, p. 58-59, illus., 1970.

Exploration of the ocean floor since the 1920's has revealed that the average depths of the oceans range from 12,000 to 18,000 feet; the continental shelf is covered by coarse terrigenous sediments and supports immense numbers of animal and plant life; the continental slope descends sharply from shelf to ocean floor, where sediments are mainly of mud; deep trenches parallel the slopes, and canyons are cut into them; the Pacific Ocean basin has rough terrane as opposed to the smooth abyssal plains common in the Atlantic; midocean ridges extend for 40,000 miles; and seamounts are created by lava from repeated eruptions. — ESL

Leach, J. W. *See* Parry, W. T. 03401

03226 **Lee, Kenneth L.** Comparison of plane strain and triaxial tests on sand: Am. Soc. Civil Engineers Proc., v. 96, paper 7276, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 901-923, illus., tables, 1970.

Data from a wide variety of sources indicate that for drained tests on sand, plane strain gives the greatest strength. Very little is known about the comparative strength and deformation properties in undrained tests. This study describes a series of drained and undrained tests on saturated sand under a wide range of density and confining pressure conditions using both triaxial and plane strain loading. It was found that, for undrained conditions, at low pressures triaxial tests gave the greatest strengths, but at high pressures the greatest strengths were determined from plane strain loading. Several arguments were offered to explain this and other observations in the behavior of plane strain versus triaxial tests on saturated sands. — *from* ASCE abstract

03633 **Lee, Kenneth L.; Shen, C. K.** Horizontal movements related to subsidence — Closure [to discussion of paper 6336, 1969]: Am. Soc. Civil Engineers Proc., v. 96, paper 7385, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1464-1466, illus., 1970.

Paper 6336 was published *in* ibid., v. 95, no. SM 1, p. 139-166, 1969; *see* Abs. North American Geology, June 1969.

Leggett, D. *See* Murrmann, R. P. 03337

03328 **Lehmann, Gerhard; Harder, Hermann.** Optical spectra of di- and trivalent iron in corundum: Am. Mineralogist, v. 55, nos. 1-2, p. 98-105, illus., tables, 1970.

Polarized absorption spectra of natural yellow, green, and blue sapphires containing iron in amounts of 0.X percent by weight have been measured. The ratio of divalent to trivalent iron was found to increase from yellow to blue samples. Anisotropy of the double band of Fe^{2+} is considerable, with absorption for the ordinary ray highest. This leads to a blue color when viewed along *c* and a yellow-green one perpendicular to it if the ratio of divalent to trivalent iron is about 0.07. Anisotropy of the bands of Fe^{3+} is small. The roles of titanium and iron in synthetic blue corundums grown by the Verneuil process are discussed, and tetravalent titanium is suggested as charge compensator for divalent iron. In yellow corundums with very low concentrations of transition metal ions, the color is caused by irradiation color centers probably not associated with transition metal ions. — *from* Authors' abstract

Leipziger, F. D. *See* Evans, C. A., Jr. 03666

Lenau, Charles W. *See* Hjelmfelt, Allen T. 03683

03237 **Lengellè, Jean-G.** Les bourrelets de congère de Luskville, Québec [Protalus moraines near Luskville, Quebec (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 321-326, illus., 1970.

The author describes parallel protalus ramparts, or moraines, near Luskville, Quebec in the Outaouais Valley. — EH

Lengellé, Jean-G. *See* Laverdière, Camille. 03239

LePichon, Xavier. *See* Pautot, Guy. 03395

03625 **Leps, Thomas M.** Review of shearing strength of rockfill: Am. Soc. Civil Engineers Proc., v. 96, paper 7394, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1159-1170, illus., tables, 1970.

The steady development of large scale triaxial shear testing equipment in the United States and Mexico in the past 20 years has permitted laboratory testing of rockfill specimens having up to 8-in. sized particles. Specimens of smaller sized particles can be tested under confining pressures of up to 2,000 psi. A review and consolidation of published test data and reports show that competent authorities have found rockfill friction angles varying widely with various parameters such as confining pressure, relative density, gradation, particle strength, degree of saturation, particle shape, and so on. The most basic parameter appears to be confining pressure, with the consistent indication being that for "average" dumped rockfill, the friction angle varies from about 55° at very low normal pressure to about 35° at very high normal pressure. — ASCE abstract

Lerman, J. C. *See* Oeschger, H. 03181

03312 **Levy, Michael A.; Pollack, Henry N.; Pomeroy, Paul W.** Motion picture of the seismicity of the Earth, 1961-1967: Seismol. Soc. America Bull., v. 60, no. 3, p. 1015-1016, 1970.

A motion picture display of the seismicity of the Earth during 1961-67 has been produced at the University of Michigan's Seismological Observatory. It emphasizes magnitude as well as chronology and location. — DBV

03085 **Lewis, Anthony J.; Macdonald, Harold C.** Significance of estuarine meanders identified from radar imagery of eastern Panama and northwestern Colombia: Modern Geology, v. 1, no. 3, p. 187-196, illus., tables, 1970.

Radar, as a potential geologic-geomorphic tool, has the capability of recording imagery of acceptable resolution, irrespective of most weather conditions and independent of solar illumination. This new data-gathering technique complements and supplements existing reconnaissance methods, and in areas of perennial cloud cover or long polar nights may prove to be the primary sensor. Radar imagery was recently obtained of eastern Panama and northwestern Colombia, areas where acquisition of aerial mapping photography has been hampered by perennial cloud cover. By interpretation of this imagery, previously unmapped estuarine meanders were detected and delineated. — *from* Author's abstract

Lewis, Brian T. R. *See* Dorman, LeRoy M. 03733

03736 **Lewis, Brian T. R.; Dorman, LeRoy M.** Experimental isostasy — [Pt.] 2, An isostatic model for the U.S.A. derived from gravity and topographic data: Jour. Geophys. Research, v. 75, no. 17, p. 3367-3386, illus., 1970.

By using a fast Fourier transform algorithm, the two-dimensional transform of the Bouguer anomaly (with terrane correction), free-air anomaly, and topography on a 32-km grid has been obtained, based on some 80,000 gravity observations and the Bouguer anomaly map of the United States. An azimuthally symmetric real function R(k) involving the Bouguer anomaly and topography gives the transfer function of the Earth to a concentrated load. The experimentally obtained R(k) is inverted to give the density change with depth causing isostatic compensation; compensation appears to be in the mantle. R(k) is also used to obtain the gravity field from the compensation and hence to construct an isostatic anomaly map. — DBV

Lewis, D. *See* Northwood, D. O. 03498

Lieber, Maxim. *See* Perlmutter, N. M. 03317

03025 **Liebermann, Robert C.; Pomeroy, Paul W.** Source dimensions of small earthquakes as determined from the size of the aftershock zone: Seismol. Soc. America Bull., v. 60, no. 3, p. 879-890, illus., tables, 1970.

Data from prominent, well-defined aftershock sequences are used to obtain evidence for source dimensions of earthquakes in the magnitude range M = 4.5 to 6. The characteristic length of the aftershock zone is defined as the longest dimension of the map view of the aftershock epicenters. On the basis of these data, the following rough limits may be placed on the likely size of small earthquakes in the western United States: for magnitude 5 events, 5 to 25 km; for magnitude 4 events, 2 to 15 km. These limits are about an order of magnitude larger than those proposed by Press [1967] for earthquakes and underground explosions and represent independent confirmation of results for earthquakes of Wyss and Brune [1968]. These results have an important bearing on recent studies of excitation of surface waves by earthquakes and underground explosions. — *from* Authors' abstract

03674 **Liebermann, Robert C.** Velocity-density systematics for the olivine and spinel phases of Mg_2SiO_4-Fe_2SiO_4: Jour. Geophys. Research, v. 75, no. 20, p. 4029-4034, illus., tables, 1970.

Substitution of 3d-transition elements for Mg and Al in the olivine, spinel, and corundum lattices causes a systematic decrease in compressional wave velocity v_p for oxides and silicates crystallizing in these structures at low pressures. New Japanese measurements of v_p for Fe_2SiO_4 spinel fit the line for spinel compounds, indicating that velocity is controlled only by density ρ and crystal structure and not by compositional details. In particular, the relationship for spinel compounds is $v_p = 15.66 - 1.59\rho$ where v_p is in kmps and ρ is in g per cm^3. By analogy, the equation for the shear wave velocity is $v_s = 9.88 - 1.17\rho$. These results suggest that the isotropic elastic properties of the spinel series in question may be predicted if only density or cell volume is known. — DBV

03267 **Liebermann, Robert Cooper.** Effect of iron content upon the elastic properties of oxides and some applications to geophysics [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5104B, 1970.

03650 **Ling, Hsin-Yi; Stadum, Carol J.** An evaluation of the Nomarski System for the study of siliceous microskeletons: Jour. Paleontology, v. 44, no. 4, p. 781-784, illus., 1970.

A new microscope attachment, the Nomarski interference-contrast system consists of a polarizing filter, an interference-contrast condenser, and an interference-contrast slide. The system applies the principle of interference by two sets of light waves to produce an image. The limited depth of field makes the study of three-dimensional objects difficult, but the specimens can be studied in balsam or hyrax, and need not be coated. — RCD

Lipps, Jere H. *See* Valentine, James W. 03346

03664 **Lipps, Jere H.** Plankton evolution: Evolution, v. 24, no. 1, p. 1-22, illus., 1970.

Marine microplankton have undergone extinctions and radiations at particular times since the Precambrian, with an apparent net increase in total diversity. These evolutionary fluctuations cannot adequately be attributed to "racial senescence," sea-level fluctuations, increased radiation, nutrient depletion, compositional changes in sea water, biologic interactions, or cooling climates. The following hypothesis seems to be supported by species distribution in modern seas: warming of high-latitude seas eliminates horizontal and, especially, vertical habitats and barriers to competition, causing extinction of the plankton morphologically specialized for those habitats; cooling of high-latitude seas creates thermally related barriers to competition, and new habitats distributed both vertically and horizontally — thus increasing opportunities for speciation of morphologically simple forms that had become widely established at times of low diversity. — VMJ

Lipschutz, M. E. *See* Laul, J. C. 03651

03268 **Little, Robert Lewis.** Lithostratigraphy and structural geology of a portion of the Dunham Ridge thrust block, Greene and Washington Counties, Tennessee [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5104B-5105B, 1970.

03305 **Liu, S. C.** Evolution power spectral density of strong-motion earthquakes: Seismol. Soc. America Bull., v. 60, no. 3, p. 891-900, illus., 1970.

This paper presents the evolutionary (time-dependent) power spectral density curves of six strong-motion earthquakes. The earthquake accelerograms are treated as piecewise-separable and the frequency-independent modulating function is estimated by applying the mean square minimization criterion. The results show that, as the time increases, the power spectral densities of earthquakes can vary both in magnitude and in peak location over the frequency axis. The analysis demonstrates that the nonstationary characteristics of earthquakes can be reasonably assessed by a simple computation procedure, and the information thus obtained can be helpful in developing improved stochastic models for earthquake simulation. — Author's abstract

Livingston, H. D. *See* Thompson, G. 03365

03295 **Lloyd, David P.** Down-the-hole TV, the greatest show in earth: Ground Water Age, v. 4, no. 10, p. 28-35, illus., 1970.

The basic function of down-the-hole TV is to record, for above ground observers, the intricacies and problems inherent in bore holes, well screens, pumps, caissons, and sewers. The simple installation belies its varied applications. A full 360° degree view is available to the geologist where the earth has been exposed to view by erosion or landslides, or the emptying of a river. The operations of the crew and several examples are described. — MCM

Lloyd, Joel. *See* Fenner, Peter. 03284

03120 **Lloyd, Mary K.; Conley, Robert F.** Adsorption studies on kaolinites [with French, German and Russian abs.]: Clays and Clay Minerals, v. 18, no. 1, p. 37-46, illus., tables, 1970.

Adsorption studies were performed on Georgia kaolins having a broad range of crystallinity and particle size distributions. Using both vapor and liquid phase adsorption techniques, surface affinities of adsorbates were determined. The preferential adsorptivity of H_2O vapor over N_2 as a function of crystallinity index and particle size was computed. For amine adsorptivity, nonaqueous adsorption isotherms were obtained. Crystallinity tends to increase toward the fine particle size range. Adsorptivities show no dependence upon crystallinity within a given particle size range. A striking anomaly occurs in the midrange of crystallinity. Its consistency points to a structural factor influential in coordination of polar molecules on kaolin. Data suggest that amines adsorb preferentially and quantitatively on the edges. — *from* Authors' abstract

03628 **Lobdell, Herbert L.** Settlement of buildings constructed in Hackensack Meadows: Am. Soc. Civil Engineers Proc., v. 96, paper 7398, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1235-1248, illus., 1970.

Observation of one-story buildings in Hackensack Meadows [N.J.] constructed over lightly preconsolidated varved clays reveals discrepancies between estimated and measured settlements. Underestimates of settlement are indicated where combined applied fill and building loads are about 1,500 psf, and overestimates where applied loads are less than 900 psf. Structural distress was minor or nonexistent where deflections of 1:240 to 1:400 were measured, as a result of differential settlement. Changes in laboratory consolidation test techniques produced no improved method for estimating settlement. Field slope readings indicated horizontal deformation to be minor. Field data have provided an empirical method for estimating settlement when loading and subsoil conditions are similar. Further regional research and field data are needed to better understand and define strain characteristics of varved clays of this area under light loads. — ASCE abstract

03231 **Lohrengel, C. Frederick, 2d.** Palynology of the Kaiparowits Formation, Garfield County, Utah: Brigham Young Univ. Geology Studies, v. 16, pt. 3, p. 61-180, illus., tables, 1969 [1970].

The Kaiparowits Formation constitutes the youngest Cretaceous rocks in central southern Utah. One 2,750-ft thick section was measured, described, and collected in the type locality (The Blues, Garfield County). Palynomorphs assignable to 80 species in 41 genera were described. One genus and 36 species are probably new but not named. Evidence is presented to show an Upper Lancian to Hell Creekian age for the formations, tentatively divided into three assemblage zones. The lower 2,200 feet of the formation was deposited as a delta in a rapidly subsiding basin; sediments indicate a western provenance. The Blues was in the fluvial portion of the delta. Sedimentation in the upper 550 feet was probably similar but is incompletely understood. Considerable volcanic activity in the region is indicated by large volumes of bentonitic material. No evidence was observed to indicate any deposition under marine conditions. — *from* Author's abstract

03631 **Londe, Pierre; Vigier, Gaston; Vormeringer, Raymond.** Stability of rock slopes — Graphical methods: Am. Soc. Civil Engineers Proc., v. 96, paper 7435, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1411-1434, illus., table, 1970.

In a previous paper the writers presented a method for the three-dimensional study of the stability of rock slopes. The weight of the various parameters on the condition of limit equilibrium can be analyzed from the assumptions taken for the geological features and the applied forces. In the present paper, several practical procedures are proposed for constructing simple diagrams allowing the same analysis. The diagrams can be constructed either by geometrical methods (e.g., stereographic or central projection of the figures drawn on a sphere) or by digital computer. Examples are given of the use of these diagrams. — ASCE abstract

Long, G. H. *See* Magnusson, D. H. 03474

03443 **Loomis, Stuart R.** Studies of morphology and stream action on ablating ice — Pt. 1, Morphology and structure of an ice-cored medial moraine, Kaskawulsh Glacier, Yukon: Arctic Inst. North America Research Paper 57, p. 1-65, illus., tables, 1970.

Marked ridge and hillock topography of the moraine is explained partially in terms of effect of its energy regime associated with local climate; crevasses, moulins, meltwater streams, and glacier flow patterns impose strong controls also. Relations between melting ice and its overlying moraine mantle include: 'glacier table' phenomenon, an appreciable debris mantle causing a decreased melting rate of underlying ice (ablation rate inversely proportional to till thickness); a thin debris layer causing increased melting rate of ice (ablation rate directly proportional to till thickness); morphological effects produced by a medial moraine's debris mantle shifting in response to mass movement processes related to varying ablation rates on the core; and establishment of an equilibrium condition in topographic relief as a result of interaction between ablation and mass wasting processes on a dynamic base. — *from* Author's abstract

03707 **Loring, D. H.; Nota, D. J. G.; Chesterman, W. D.; Wong, H. K.** Sedimentary environments on the Magdalen shelf, southern Gulf of St. Lawrence: Marine Geology, v. 8, no. 5, p. 337-354, illus., 1970.

Oblique sonarograms, echograms, and bottom samples reveal that a relict sedimentary environment composed of uncovered bedrock and unsorted sand and gravel deposits, occurs north of Prince Edward Island and in the nearshore areas of the Magdalen Islands. Recent depositional processes have produced major changes in the microtopography and texture of relict sediments on offshore banks. The relict sediments in these areas have been and are being reworked, sorted, and redistributed by the present current regime. A depositional environment also exists in the troughs and to a lesser extent in the intervening lows between the banks. Fine-grained sediments have buried the relict sediment cover and modified the morphology in these areas. — *from* Authors' abstract

Lormeyer, David H. *See* Meyer, Walter R. 03768

03763 **Losche, C. K.; McCracken, R. J.; Davey, C. B.** Soils of steeply sloping landscapes in the southern Appalachian Mountains: Soil Sci. Soc. America Proc., v. 34, no. 3, p. 473-478, tables, 1970.

A lack of variety of precursor minerals in the highly siliceous parent materials is a possible explanation for the soil profile similarity on the north- and south-facing landscapes in southwestern Virginia. In contrast, soils developed from a granitic biotite gneiss possess distinctly different characteristics on the opposing north- and south-facing landscapes in southwestern North Carolina. A greater variety of precursor minerals, higher precipitation, and the aspect-related soil temperature difference are suggested as the primary reasons for this profile differentiation at the two slope positions and two aspects studied. Kaolin and the pedogenic 2:1-2:2 intergrade minerals are predominant in soils on the north-facing landscape and gibbsite in soils of the south-facing landscape. — Soil brief

03616 **Lovell, J. P. B.** Erratum [Tyee Formation, a study of proximality in turbidites, 1969]: Jour. Sed. Petrology, v. 40, no. 2, p. 774, illus., 1970.

The original paper (ibid., v. 39, no. 3, p. 935-953) is cited in Abstracts of North American Geology, April 1970.

03123 **Low, Philip F.; White, Joe L.** Hydrogen bonding and polywater in clay-water systems: Clays and Clay Minerals, v. 18, no. 1, p. 63-66, illus., 1970.

Examination of infrared spectra of clay-water systems for evidence of polywater was inconclusive, but there is indirect evidence that polywater, or a similar species of water, does exist in these systems; nine points in proof are given. It is proposed that previous conclusions regarding the state of hydrogen bonding in clay-water systems be accepted with reservation, and that additional infrared studies be undertaken for the purpose of elucidating the kinds of hydrogen bonds that exist therein. — ESL

03179 **Lowdon, J. A.** Carbon-isotope fractionation during dry combustion of oxalic acid: Radiocarbon, v. 12, no. 2, p. 347-349, table, 1970.

Results obtained in the Geological Survey of Canada laboratory over a nine-year period indicate that the dry combustion method of preparing CO_2 from oxalic acid is reliable and gives reproducible results, provided time and care are taken to convert more than 90 percent of the carbon to CO_2. The major annoyance in the method is the length of time (about four hours for 30 gms of oxalic acid) involved in sample preparation. — MCM

03183 **Lowdon, J. A.; Wilmeth, R.; Blake, W., Jr.** Geological Survey of Canada radiocarbon dates X: Radiocarbon, v. 12, no. 2, p. 472-485, tables, 1970.

03373 **Lowell, Brent H.; Morgan, Charles O.; McNellis, Jesse M.** Brief descriptions of and examples of output from computer programs developed for use with water data in Kansas: Kansas Geol. Survey Spec. Distrib. Pub. 48, 54 p., illus., tables, 1970.

Programs written in FORTRAN IV language have been developed in the Kansas District of the U.S. Geological Survey to handle basic water data by use of the digital computer. The programs check, tabulate, graph, map, and statistically analyze data derived from hydrologic and geologic investigations. — Authors' abstract

Lukens, H. R. *See* Graber, F. M. 03648

Lundquist, G. M. *See* Howell, B. F., Jr. 03307

Lyall, Anil K. *See* Swift, Donald J. P. 03745

03171 **Lyon, Stephen R.; Ehlers, Ernest G.** The system MgO-GeO_2-H_2O: Am. Mineralogist, v. 55, nos. 1-2, p. 118-125, illus., tables, 1970.

The system MgO-GeO_2-H_2O is analogous to the system MgO-SiO_2-H_2O in having structures analogous to serpentine, talc, enstatite, olivine, stishovite, and quartz. In addition, both systems do not contain any of the humite-type minerals; apparently some MgF_2 is necessary in place of $Mg(OH)_2$ for successful synthesis. Anthophyllite is difficult to synthesize in both systems. A new compound $Mg_4GeO_6Mg(OH)_2$, alters previously reported tie-lines in the system. — JWC

03176 **Lyons, J. B.; Morse, S. A.** Mg/Fe partitioning in garnet and biotite from some granitic, pelitic, and calcic rocks: Am. Mineralogist, v. 55, nos. 1-2, p. 231-245, illus., tables, 1970.

The distribution coefficient Mg:Fe for garnet-biotite pairs in calcium-rich metamorphic rocks from New Hampshire of the garnet to kyanite zones is significantly lower (0.10 ± 0.01) than that in isogradic pelitic schists (0.16 ± 0.02). Sillimanite zone pelitic rocks show a wide range in the distribution coefficient (0.16 ± 0.03) but much lower values than those in the enclosed Kinsman Quartz Monzonite (0.28 ± 0.03), which has been variously described as magmatic, granitized, or metamorphic. The Kinsman and the enclosing pelitic rocks have closely similar chemical compositions and mineral assemblages and formed under high load pressure, low to intermediate oxygen fugacity, and probably similar water fugacity. Thus the higher distribution coefficient of the Kinsman rocks is taken as evidence of a higher temperature of formation, probably magmatic in origin. — *from* Authors' abstract

03353 **Lysmer, John.** Lumped mass method for Rayleigh waves: Seismol. Soc. America Bull., v. 60, no. 1, p. 89-104, illus., tables, 1970.

A simple numerical method is developed for the analysis of generalized Rayleigh waves in multilayered elastic media. The method which completely avoids the use of displacement potentials leads to a simple eigenvalue problem which may be solved by generally available effective computer codes. Numerical results obtained by the method show excellent agreement with previously published solutions obtained by other theories. — Author's abstract

03557 **Lysne, P. C.** A comparison of calculated and measured low-stress Hugoniots and release adiabats of dry and water-saturated tuff: Jour. Geophys. Research, v. 75, no. 23, p. 4375-4386, illus., tables, 1970.

Hugoniots of water, four dry tuffs, and two water-saturated tuffs in the low-stress region were determined in gas gun experiments; states on release adiabats of dry tuff specimens were determined by shock reverberation techniques. The experimental water Hugoniot agreed well with a Hugoniot calculated from thermodynamic data. Experimental states are compared in the tuff and states calculated on several assumptions that volume changes due to shock heating are negligible, rigidity of the solid portion is responsible for presence of the precursor and determines both its velocity and magnitude; and a hydrodynamic, completely compacted state is achieved immediately and irreversibly once the Hugoniot elastic limit is exceeded. Calculated stress-particle velocity states averaged about 30 percent in stress less than values measured on dry specimens, indicating that compaction is not completed in the duration of the experiments. Measured and calculated states agreed for saturated samples. — DBV

Macdonald, Harold C. *See* Lewis, Anthony J. 03085

MacDougall, A. R. *See* Calder, Peter N. 03457

03735 **Macintyre, Ian G.** Sediments off the west coast of Barbados, diversity of origins: Marine Geology, v. 9, no. 1, p. 5-23, illus., tables, 1970.

Carbonate material that did not form in the present environment occurs in sediments of three sediment facies recognized in this study area: shoreward of depths of 70 feet, insular shelf facies are mainly modern skeletal material along with detrital deposits; between 70 and 400 feet, upper slope facies are a mixture of relict residual, modern organic and volcanic material; seaward of 400 feet, slope facies sediments are mainly residual material from submarine outcropping beds but include some volcanic and modern organic material. Pyroclastic material was derived from La Soufrière on St. Vincent, 100 mi west of Barbados; the non-carbonate fraction of insular shelf sands is mostly detrital quartz. Grey discoloration in carbonate grains, caused primarily by diagenetic pyrite, occurs in grains transported into stagnant, ponded river mouths common along the Barbados west coast. — *from* Author's summary

MacKenzie, J. K. *See* Graber, F. M. 03648

Mackin, J. Hoover. *See* Schmidt, Dwight L. 03379

Madariaga, Raúl. *See* Husebye, Eystein. 03308

03474 **Magnusson, D. H.; Long, G. H.** Atlantic continental margin, its history, its future, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 693, p. 25-30, illus., 1970.

Most of the continental shelf province of the Atlantic margin appears to be a submerged extension of the Coastal Plain, composed of Tertiary, Cretaceous, and Jurassic strata. Seismic studies suggest a thickness of over 25,000 feet. Sediments slumped from the shelf, down the slope, onto the rise, which is considered to be a prism-shaped body of turbidites. The petroleum industry became active in the area in 1960, and several exploratory wells have been drilled in the Grand Banks and Scotian shelf areas. Petroleum reserves of the eastern Canada offshore area are estimated to be 24.75 billion bbls of oil and 150 trillion cubic feet of gas. Some of the increased indirect and direct geoscience activity to be expected is discussed, and objectives and future trends described. Solid-earth sciences will play a paramount role in development of the Atlantic continental margin. — ESL

Mal, A. K. *See* Knopoff, L. 03679

03331 **Malcolm, Ronald L.; Kennedy, V. C.** Variation of cation exchange capacity and rate with particle size in stream sediment: Water Pollution Control Federation Jour., v. 42, no. 5, pt. 2, p. R153-R160, illus., table, 1970.

Results are reported of a study of the variation in cation-exchange capacity and cation-exchange rate with particle size of stream sediments from the Mattole River of northern California. A potassium specific-ion electrode was used to determine the rate of Ba-K exchange and the cation exchange capacity (CEC) of the size-fractionated stream sediment. The time required for 75 percent completion of exchange ranged from 3 sec for clay fractions to 12 hr for gravels. Average CEC of clay, silt, sand and gravel fractions was 37.6, 11.0, 9.7, and 7.2 meq/100 g, respectively. Organic matter contributed about 15 percent of the total CEC of the sediment. The CEC of sand and gravel fractions exclusive of organic matter was 5.5 to 8.0 meq/100 g; they must be included in a consideration of the total exchange, chemical properties, and transport phenomena of the stream. — *from* Authors' abstract

03098 **Malhotra, Anil Kumar.** Stochastic analysis of offshore tower structures [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4610B, 1970.

03757 **Manghnani, Murli H.** Analcite-jadeite phase boundary, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 456-461, illus., tables, 1970.

Thirty-one P-T runs were made, using a piston-cylinder apparatus, to study the phase boundary of the reaction analcite $\rightleftharpoons$ jadeite + vapor (H_2O). The starting material was a stoichiometric mixture of the products and reactants. Reversal of the reaction was obtained. The phase boundary is given by the equation, $P = 4000$ bars $+ 10.5\ T(°C)$. At about 10 kb and 600°C the phase boundary is intersected by the melt curve, jadeite + vapor $\rightleftharpoons$ liquid which has a steeper slope. The previously determined phase boundary of the reaction, nepheline + albite $\rightleftharpoons$ 2 jadeite (Robertson and others, 1957) also passes through this invariant point. The above experimental method was also adopted to extend further the studies by Yoder (1954) and Greenwood (1961) of the reaction, 1/2 nepheline + 1/2 albite + $H_2O \rightleftharpoons$ analcite. The results of the 13 runs for this reaction fit well with their data as well as the data of Boettcher and Wyllie (1967). — Author's abstract

Mann, J. A. *See* Cherry, R. N. 03383

03503 **Manning, P. G.; Harris, D. C.** Optical-absorption and electron-microprobe studies of some high-Ti andradites: Canadian Mineralogist, v. 10, pt. 2, p. 260-271, illus., tables, 1970.

Electron-microprobe and optical-absorption spectra are reported of yellow/brown thin sections of some melanites and schorlomites and also of some pink high-Ti andradites from San Benito County, California. Ti^{3+}:Ti^{4+} ratios for the above garnets have been calculated, from which it is concluded that Ti substitutes as Ti^{3+} for octahedral Fe^{3+} in the pink andradites, whereas in the yellow/brown melanites and schorlomites the titanium appears to exist predominantly as Ti^{4+}, substituting in part for tetrahedral silicon. The pink titanian andradites can therefore be considered as a different variety from melanite or schorlomite. — Authors' abstract

Manuel, O. K. *See* Bennett, G. A. 03140

03730 **Mao, Nai-Hsien; Ito, Jun; Hays, J. F.; Drake, John; Birch, Francis.** Composition and elastic constants of hortonolite dunite: Jour. Geophys. Research, v. 75, no. 20, p. 4071-4076, tables, 1970.

New chemical analyses are given for samples of hortonolite dunite from the Mooihoek Mine, Transvaal, and from the type locality at Monroe, New York, and measurements are given of wave velocities to 10 kb for the Monroe hortonolite. The olivine of the Mooihoek hortonolite has the composition $Fo_{44}Fa_{56}$, but about 10 percent has been altered. The olivine of the Monroe hortonolite has the composition $Fo_{37}Fa_{57}Te_6$, and the velocities and density are somewhat higher than those of the Mooihoek rock. Extrapolation to fayalite suggests that the compressibility changes relatively little with iron content in the forsterite-fayalite series. — Authors' abstract

03097 **Marachi, Nezameddin.** Strength and deformation characteristics of rockfill materials [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4610B, 1970.

03580 **Margherita, Lucio.** Display techniques as an aid to aeromagnetic interpretation: Canadian Petroleum, v. 11, no. 6, p. 12-13, 16-18, illus., 1970.

It is the right of the field geophysicist to place a sheet of transparent paper on his total magnetic intensity map and produce a geological interpretation. The rules are: the steepness of the anomaly is somewhat related to the depth of its source, its size is a function of the susceptibility contrast, and its shape is an expression of the actual shapes of the object producing it. The accuracy of an interpretation based on these rules is directly proportional to the experience and ingenuity of the geophysicist. If the survey has been recorded accurately with close enough sample spacing and a reasonably low flight altitude, the total intensity contains all the information needed for evaluation of an area. However, relevant data may be buried under spurious data which we may want to filter out. Can we display our data in different fashions only emphasizing the parts that may be considered significant, — *from* Author's abstract

03637 **Markl, R. G.; Bryan, G. M.; Ewing, J. I.** Structure of the Blake-Bahama outer ridge: Jour. Geophys. Research, v. 75, no. 24, p. 4539-4555, illus., 1970.

Recent high-resolution seismic reflection profile data substantiate the depositional nature of the Blake-Bahama outer ridge and show that its sedimentary structure is quite complex. The structure is revealed principally by the configuration of the prominent acoustic reflectors X and Y observed above horizon A. Layer A-X was deposited preferentially along the ridge axis, establishing the over-all shape. Two major sedimentary regimes are distinguished above reflector X: a "northern" regime, which mantles the crest of the northern half of the ridge, and a younger "southern" regime which laps onto the northern and creates sharp unconformable contacts in some localities. The most important of these contacts divides the regimes at latitude 30°15′ N and suggests that the post reflector X depositional history of the ridge north and south of this latitude is different. — *from* Authors' abstract

03034 **Marsell, Ray E.** Cloudburst floods, *in* Governor's conference on geologic hazards in Utah, December 14, 1967: Utah Geol. and Mineralog. Survey Spec. Studies 32, p. 11-17, illus., tables, 1970.

Due to topography and climate, 85 percent of Utah's population is located in a strip 10 mi wide and 100 mi long along the Wasatch Front, an area that is the most

harardous cloudburst flood zone in the State. Flash floods commonly discharge large volumes of debris (mud, rocks, boulders, etc.) as well as free water. Viscosity enables the mud rock flow to maintain appreciable depth even on unconfined surfaces and to override obstacles. Evidence supports both the man-made flood view and that of the natural geologic occurrence; the truth may lie somewhere between. No fallible system for controlling floods has been devised. — MCM

Mast, R. F. *See* Swann, D. H. 03059

Matlock, William G. *See* Sorey, Michael L. 03617

Matsch, Charles L. *See* Hogberg, Rudolph. 03491

03456 **Maurice, O. D.** Limestones and dolomites of Quebec [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 283, 1970.

03159 **Mazor, Emanuel; Heymann, Dieter; Anders, Edward.** Noble gases in carbonaceous chondrites: Geochim. et Cosmochim. Acta, v. 34, no. 7, p. 781-824, illus., tables, 1970.

He, Ne, Ar, Kr, and Xe were measured in 73 samples of 32 carbonaceous chondrites and 3 ureilites. All carbonaceous chondrites contained planetary primordial gas; many also contained solar gas. Types I, II, and III V always had sizeable contents of He and Ne; Types III O, C4, and ureilites had little or no primordial He and Ne. These trends were probably established during accretion rather than during metamorphism. Primordial He shows a more than threefold variation in the He-3/He-4 ratio, while much smaller variations were found for Ar-36/Ar-38. Radiation ages from Types I and II were always less than 15 m.y., while those for Type III extended to 40 m.y., a trend which correlates with crushing strength. K-Ar ages increase in the order I < II < III, probably reflecting increasing grain size and gas retentivity. — GV

03064 **McCarthy, James A.** The Miocene trend of Calhoun and Matagorda Counties, Texas: South Texas Geol. Soc. Bull., v. 10, no. 7, p. 6-21, illus., 1970.

The stratigraphy, structure and geologic history of the Miocene formations of the Gulf Coast of Texas are discussed. The most productive parts are the upper Middle and Middle Miocene, where 91 percent of the producing wells are located. There are an unlimited number of large untested anomalies available for exploration and the Miocene uplift offers opportunities for the discovery of a large gas field. Gravity, isopach, and structure maps are included. — EH

McCartney, W. D. *See* Sangster, A. L. 03454

03591 **McConnell, Duncan.** Arsenic in phosphorite and apatite — Discussion [of paper by S. H. Stow, 1969]: Econ. Geology, v. 65, no. 1, p. 64-65, 1970.

For original paper, *see* ibid., v. 64, no. 6, p. 667-671, 1969; Abs. North American Geology, April 1970.

McConnell, R. K. *See* Aronson, J. R. 03695

McCracken, R. J. *See* Losche, C. K. 03763

03201 **McCullagh, M. J.; King, C. A. M.** SPITSYM, a FORTRAN IV computer program for spit simulation: Kansas Geol. Survey Computer Contr. 50, 20 p., illus., 1970.

The development and operation of a program to simulate the formation of a shingle spit is described; this includes a detailed account of action of the subroutines that simulate the four major processes that are thought to act on the spit. The simulation relies on stochastic techniques and the program is concerned with building a spit in a 50-row by 60-column matrix so that the results of the process are graphically displayed. — *from* Authors' abstract

McCulloch, David S. *See* Carlson, Paul R. 03078

McDougall, D. J. *See* Douglas, G. 03086

03131 **McDougall, David J.** La thermoluminescence des roches métamorphiques (note préliminaire) [Thermoluninescence of metamorphic rocks (preliminary note)]: Soc. Geol. France Bull, 1969, 7th ser., v. 11, no. 3, p. 323-329, illus., 1970.

Enough changes, caused by heat and pressure, occur in thermoluminescence of calcite, quartz and feldspar to provide a basis for a preliminary statement of general principles on the relation between thermoluminescence and facies of metamorphic rocks. The principles are seemingly confirmed by field studies in areas of contact metamorphism. Examples of thermoluminescence of rocks from various areas in Canada are cited. — *from* Author's abstract

McGinnis, Michael R. *See* Strimple, Harrell L. 03727

03428 **McGinty, Thomas L.** Mollusca of the "Glades" unit of southern Florida — Pt. 1, Introduction and observations: Tulane Studies Geology and Paleontology, v. 8, no. 2, p. 53-56, 1970.

The "Glades" unit, not yet formally named, is a distinctive shell deposit of early Pleistocene(?) age lying above the Pliocene Caloosahatchee Marl and below the Pleistocene Fort Thompson Formation in seven counties of southern Florida. The "Glades" molluscan fauna contains some upper Miocene and Pliocene species, but also species peculiar to itself; many mollusks living today in the Gulf and Caribbean Sea appear to have evolved from it. Environmental conditions as indicated by the fauna at Belle Glade rock pit were similar to those off the ocean side of the Florida Keys today, although brackish, fresh-water, and land facies are also represented. The fauna west of Ortona Lock represents a more rocky situation. Some bivalve and gastropod species are listed for the two localities, and marker fossils are listed for the "Glades" unit and Caloosahatchee Marl. – VMJ

03136 **McGowen, J. H.; Garner, L. E.** Physiographic features and stratification types of coarse-grained point bars, modern and ancient examples: Sedimentology, v. 14, nos. 1-2, p. 77-111, illus., table, 1970.

Primary structures in modern point bars of the Amite River in Louisiana and the Colorado River of Texas are analogous to features in the Eocene Simsboro and Pleistocene Colorado River deposits of the Texas Coastal Plain. Short-duration peak flow, channel pattern, average stream gradient of about 2-3 ft/mi, and bank stabilization by dense vegetation are major parameters controlling the deposition in the Amite and Colorado Rivers. Differences between point bars of bed-load streams and mixed-load streams are that upper point-bar sediments with small trough sets and parallel inclined laminae occur only in fine-grained fluvial deposits, and large-scale foresets of chute bars are common to coarse-grained fluvial deposits but are not found in fine-grained fluvial deposits. [These features are identified in the ancient deposits.] — *from* Authors' abstract

McGregor, Ronald L. *See* Bare, Janét E. 03195

03523 **McHenry, J. Roger; Gill, Angela C.** Measurement of soil moisture with a portable gamma ray scintillation spectrometer: Water Resources Research, v. 6, no. 3, p. 989-992, illus., tables, 1970.

Equipment used, in addition to the scintillation detector, was a scaler-ratemeter with power pack, and a pulse height analyzer. The moisture of sediments is determined as a function of total density using attenuation of Cs-137 gamma rays. Several representative studies are described. Changes in soil moisture in a 36-inch profile as a function of rainfall, soil cover, and profile characteristics are tabulated. — ESL

McIlroy, Paul. *See* Kingston, Gary A. 03208

McKeown, F. A. *See* Yacoub, Nazieh K. 03698

McManus, Dean A. *See* Grim, Muriel S. 03706

03280 **McMillan, W. J.** West flank, Frenchman's Cap gneiss dome, Shuswap terrane, British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 99-106, illus., tables, geol. map, 1970.

Structural studies on the west flank of Frenchman's Cap gneiss dome embraced the western core zone of mixed gneiss, uniform granite gneiss, and gneissic granite; mantling metasedimentary rocks containing a concordant nepheline syenite gneiss that is probably a sill; and fringing zone of metasedimentary gneisses with pegmatite. Mantling rocks comprise quartzite with local quartz-pebble conglomerate, paragneiss and schist, marble and calc-silicate. On the west flank deformation was in two major phases followed by a third minor episode. Structural trends in the core zone are dominated by northwesterly plunges and are more irregular than in the mantling zone. No structures earlier than Phase 1 were recognized in core gneisses. The metamorphic grade apparently increased gradually to upper amphibolite facies during Phase 1, maintained this level during Phases 1′ and 2, and decreased prior to Phase 3. — *from* Author's abstract

03708 **McNary, J. F.; Frohlich, H.** An in situ sediment vane shear testing device: Marine Geology, v. 8, no. 5, p. 367-370, illus., 1970.

A compact self-contained motor driven in situ sediment vane shear tester has been developed. This device can be used to measure the shear strength of sea-floor sediments either by diver or from a manned submersible. — Authors' summary

McNeill, J. D. *See* Barringer, R. R. 03459

McNellis, Jesse M. *See* Lowell, Brent H. 03373

03273 **McTaggart, K. C.; Wheeler, J. O.** An appreciation — James Aubrey Coates, 1931-1968, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, preceding page 1, portrait, 1970.

03282 **McTaggart, K. C.** Tectonic history of the northern Cascade Mountains, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 137-148, illus., table, 1970.

The Northern Cascade Mountains and the southern part of the Coast Crystalline Belt offer two views of the same orogen. The former, composed mainly of folded and faulted sedimentary, volcanic and metamorphic rocks, displays the slightly eroded upper levels of the orogen. Westerly and easterly-spreading thrusts root near a central crystalline and metamorphic axial zone. The Coast Crystalline Belt, composed largely of granitic plutons with numerous roof pendants, reveals deeper levels of the orogen. Overlying thrust plates have been removed and the steep root zones of the thrusts and the central crystalline axis can be followed northwest into the plutonic zones. Structures strike northwest. Anomalous northeast-striking recumbent folds in the boundary area between the two regions were probably produced by late orogenic gravity-controlled sliding. — *from* Author's abstract

03416 **Medaris, L. G., Jr.; Dott, R. H., Jr.** Mantle-derived peridotites in southwestern Oregon, relation to plate tectonics: Science, v. 169, no. 3949, p. 971-974, illus., table, 1970.

A group of peridotites in southwestern Oregon contains high-pressure mineral assemblages reflecting recrystallization at high temperatures (1100° to 1200°C) over a range of pressure decreasing from 19 to 5 kilobars. It is proposed that the peridotites represent upper-mantle material brought from depth along the ancestral Gorda-Juan de Fuca ridge system, transported eastward by the spreading Gorda lithosphere plate, and then emplaced by thrust-faulting in the western margin of the Cordillera during late Mesozoic time. — Authors' abstract

Medaris, L. Gordon, Jr. *See* Cullers, Robert L. 03349

03403 **Menzer, Fred J., Jr.; Swanberg, Chandler A.; Taylor, H. C.** The Darling Lake mafic and ultramafic pluton, Washington — Petrology, gravity and structure: Northwest Sci., v. 44, no. 2, p. 95-101, illus., table, 1970.

Darling Lake pluton, near Okanogan, Wash., is a small stock with 2,000 feet of vertical exposure and a surface area slightly less than one sq mi, forcefully emplaced after mid-Mesozoic regional metamorphism. Contacts between its gabbro and interior pods of ultramafic rocks are gradational; absence of chilled margins and mineralogy of contacts suggest mechanical mixing of the two rock types while relatively fluid. Lack of inclusions of country rock and local spreading of the schists and gneisses near the contact indicate they may have been hot and pliable. From measured gravity densities at 250 stations along three profiles, in an area 20 × 15 mi, a tear-drop shape is indicated with roughly circular outcrop. The pluton may represent an early mafic differentiate of the Cretaceous magmatic cycle in north-central Washington. — GDC

03466 **Mero, John L.** The past, present and future of ocean mining [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 299, 1970.

03216 **Merrell, William J., Jr.; Huebner, George L., Jr.** New aerial photo techniques are available for offshore industry: Offshore, v. 30, no. 3, p. 90-93, illus., 1970.

Some principles are reviewed of color photography with different types of film that respond to selected primaries of red, green, and blue; a typical type of color transparency film in common use is described. For offshore application, only the determination of the land-sea interface, bathymetry, and circulation patterns through use of aerial photography are discussed here; dramatic coastal changes can be compared in permanent mosaics. Contrasting effects off the Mississippi delta, by use of different films, are illustrated. The same light intensity which would penetrate extremely clear ocean water to a depth of 100 m in the Bahama Banks area penetrates turbid coastal water to but 10 m. Results with black and white IR film, and with use of yellow filter are given also. Bathymetry can be inferred also from its influence on surface waves. — GDC

03692 **Merrill, Ronald T.** Low-temperature treatments of magnetite and magnetite-bearing rocks: Jour. Geophys. Research, v. 75, no. 17, p. 3343-3349, illus., 1970.

Low-temperature treatments and alternating-field demagnetization of magnetite samples are compared. Both theory and experiments show that these treatments affect different parts of the coercive force spectrum of magnetite. Some secondary magnetization can survive low-temperature 'cleaning.' The combination of low-temperature treatment with af demagnetization may be useful in separating behavior in multidomain regions from that in single-domain regions. — Author's abstract

03585 **Messina-Allen, S.; VanLandingham, Sam L.** Physicochemical conditions of deposition of Bacillariophyta in Davis Lake, Klamath and Deschutes Counties, Oregon, U.S.A. [with Spanish and German summ.]: Hydrobiologia, v. 35, no. 1, p. 31-44, illus., tables, 1970.

A diatomaceous deposit, probably of Holocene age, containing 74 diatom species and varieties, was found at the mouth of Odell Creek at Davis Lake, Klamath County, Oreg. Ecological characteristics of each taxon of the Davis Lake assemblage are tabulated, and the assemblage is compared with those of seven other North American diatomaceous deposits of Miocene to Holocene age, on the basis of halabion, saprobic, current, pH, habitat, and nutrient spectra. Composition of the Davis Lake assemblage, almost equally of planktonic and nonplanktonic forms, indicates alkaline, oligohabous (indifferent), oligosaprobic, and eutrophic ecological conditions, and limnobiontic to indifferent current conditions. Ecological spectra at Davis Lake denote deposition in a bog or swale that could have been part of a drainage basin for runoff from volcanic uplands. — VMJ

03768 **Meyer, Walter R.; Gutentag, Edwin D.; Lormeyer, David H.** Geohydrology of Finney County, southwestern Kansas: U.S. Geol. Survey Water-Supply Paper 1891, 117 p., illus., tables, geol. map, 1970.

In Finney County, unconsolidated Tertiary and Quaternary sediments form the principal ground-water reservoir and attain a thickness of more than 500 feet in the southwestern part; sand and gravel beds of the Pliocene Ogallala Formation contain a greater amount of interbedded and mixed silt, clay, and caliche than do those of the

undifferentiated Pleistocene deposits. Minor amounts of water for domestic and stock purposes are available from aquifers in Lower Cretaceous deposits and possibly from the Upper Jurassic Morrison(?) Formation. Analyses of water-table-contour maps indicate a constant inflow of 40.2 mgd and a constant outflow of about 42.0 mgd. Water quality ranges from good in Pliocene and Pleistocene deposits of the southern section to poor in Pleistocene and Holocene alluvium of the central section. Water in about half the area is undesirable for domestic purposes. — *from* Authors' abstract

Meyerhoff, A. A. *See* Hatten, C. W. 03754

Meyers, James F. *See* Gray, Richard E. 03629

03593 **Miall, Andrew D.** Devonian alluvial fans, Prince of Wales Island, Arctic Canada: Jour. Sed. Petrology, v. 40, no. 2, p. 556-571, illus., tables, 1970.

The Peel Sound Formation, a continental conglomerate with minor sandstones forms a belt 150 miles long and up to 10 miles wide. It reaches 1,000 feet in thickness, and towards the west coarse clastics intertongue into sandstones which grade into shales and carbonates. Provenance is the Boothia uplift. Poor sorting and pebble sizes compare with modern alluvial fan deposits; areal variations are due to dispersal on eleven fans. Grain-size and clast-roundness variations are inter-fan in origin. Maximum clast size reveals intra-fan changes, namely decrease with distance of transport. Clast changes in vertical section are attributed to varying rates of uplift and erosion in the source area. Comparison of grain size and textural characteristics of the conglomerates with those of modern deposits suggests a debris flood mode of origin. — HRC

Mickle, Jack L. *See* Russell, Eugene R. 03229

03460 **Middleton, R. S.; Pyke, D. R.** Distribution and characteristics of the sulphide ores of the Timmins area [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 289, 1970.

03335 **Milici, Robert C.** Middle Ordovician stratigraphy in central Sequatchie Valley, Tennessee: Tennessee Div. Geology Rept. Inv. 30, p. 111-127, illus., tables, reprinted 1970; originally published 1969.

This paper is reprinted from Southeastern Geology, v. 11, no. 2, 1969; *see* Abstracts of North American Geology, August 1970.

Miller, Donald S. *See* Schroeder, Johannes H. 03602

Miller, James A. *See* Swift, Donald J. P. 03745

Miller, Thomas P. *See* Patton, William W., Jr. 03413

Millett, Frank B., Jr. *See* Williams, Sidney A. 03505

03741 **Mining Engineering.** Industrial minerals of 1969, their status, challenge, and future [abs.]: Mining Eng., v. 22, no. 1, p. 46-70, illus., tables, 1970.

This article is an annual review of the status of the industrial minerals in 1969. Materials ranging from barite to zircon are discussed in detail by various authors. — MAC

03110 **Minke, Joseph Garrett.** Petrology of dolomites in the Everton Formation, Marion County, Arkansas [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4664B, 1970.

03609 **Minter, W. E. Lawrence.** Origin of mud polygons that are concave downward: Jour. Sed. Petrology, v. 40, no. 2, p. 755-756, illus., 1970.

Rare mud polygons, concave downward, developed in mud deposited during flooding of a stream bank. Relative elevation and thinness of the deposit appears to have caused more rapid drainage than evaporation, with consequent downward curling of the polygon edges. — Author's abstract

Mitchell, Richard S. *See* Ehlmann, Arthur J. 03166

03714 **Miyashiro, Akiho; Shido, Fumiko.** Progressive metamorphism in zeolite assemblages: Lithos, v. 3, no. 3, p. 251-260, illus., table, 1970.

Zeolites in metamorphic rocks are assumed to form in equilibrium with a fluid phase of virtually pure H_2O composition, and successive increases in metamorphic temperature are assumed to result in progressive dehydration in zeolite assemblages. For Ca- and also for Na-zeolite assemblages, four steps of dehydration are recognized which are generally consistent with petrographic data on progressive metamorphism in zeolite facies areas in the world. — Authors' abstract

03135 **Moberly, Ralph, Jr.** Microprobe study of diagenesis in calcareous algae: Sedimentology, v. 14, nos. 1-2, p. 113-123, illus., 1970.

Initial results of investigation of the diagenesis of calcareous algae by electron microprobe are: (1) A few conceptables and other cavities in Recent algae specimens are partly to completely filled with younger carbonate. In contrast to the surrounding skeleton of about 10-20 percent mol $MgCO_3$-calcite, these deposits are either very low (0-2 percent) or very high (15-50 percent) in $MgCO_3$ content. (2) Highest magnesian values in Recent algae studied are thought to be in high-Mg calcites rather than in any other phase, with very few possible exceptions. (3) Calcian dolomite replacing fossil algae in cores from Eniwetok Atoll commonly has Ca-rich lenses resembling exsolution laminae. — Author's abstract

03623 **Mogridge, Geoffrey R.** Testing sediment movement due to wave action: Am. Soc. Civil Engineers Proc., v. 96, paper 7433, Jour. Hydraulics Div., no. HY 7, p. 1587-1604, illus., tables, 1970.

The development of laboratory equipment to simulate the water particle motion at the sea bed due to wave action is described. Essentially it oscillates a block of water horizontally in a flume. An inverted U-frame constraining the water measures 84 in. long by 48 in. wide by 24 in. high and is large enough to reproduce prototype boundary conditions. A piston drive is supplied by high pressure oil and motion is controlled to follow a sinusoidal input movement. Previous attempts to model wave action for the study of sediment movement are analyzed and the benefits of the present design are outlined. It is proposed that the equipment be used to study the effects of superimposed wave trains and mass transport velocity on sediment movement. — ASCE abstract

Mohamed, S. M. M. *See* Andersland, Orlando B. 03027

03173 **Moore, Paul B.** Crystal chemistry of the basic iron phosphates: Am. Mineralogist, v. 55, nos. 1-2, p. 135-169, illus., tables, 1970.

Crystal structure of the basic iron phosphates is dictated by the ways in which fundamental polyatomic octahedral face-sharing triplets and their nearest neighborhood of octahedra link along a third "variable" axis. Refined crystal structures of dufrenite and rockbridgeite are given. Structure cell and indexed powder data are presented for dufrenite, souzalite, rockbridgeite, beraunite, laubmannite, and mineral A (new). Basic ferrous-ferric phosphates that possess or may possess the octahedral face-sharing three-cluster are listed. Their pleochroism is discussed. Paragenetic schemes are proposed for some of these minerals; typical sequences involve denser phases followed by higher hydrates. — *from* Author's abstract

03397 **Moore, Paul B.** Structural heirarchies among minerals containing octahedrally coordinating oxygen — [Pt.] 1, Stereoisomerism among corner-sharing octahedral and tetrahedral chains: Neues Jahrb. Mineralogie Monatsh. 1970, no. 4, p. 163-173, illus., 1970.

Several mineral structures have corner-sharing Fe^{3+}- and Al^{3+}-oxygen octahedral chains in which the octahedrons are joined through opposite vertices by $(OH)^-$ groups. Adjacent octahedral chain segments are linked by two $(PO_4)^{3-}$ or $(SO_4)^{2-}$ tetrahedral vertices. In some cases tetrahedrons further link by a third vertex to adjacent octahedral chains. There are seven possible stereoisomers involving tetrahedrons linked to the chains; these are the basis of a sizeable number of mineral species. Stereoisomerism appears to be an important basis for the large number of species involving Te^{3+}- and Al^{3+}-cations and $(OH)^-$, (H_2O), $(PO_4)^{3-}$, and $(SO_4)^{2-}$-ligands. — DBV

Moore, William J. *See* Fabbi, Brent P. 03326

Moran, Stephen R. *See* Gross, David L. 03611

Morency, M. *See* Douglas, G. 03086

Morey, G. B. *See* Sims, Paul. 03582

Morgan, Charles O. *See* Lowell, Brent H. 03373

03170 **Morimoto, Nobuo; Koto, Kichiro.** Phase relations of the Cu-S system at low temperatures — Stability of anilite: Am. Mineralogist, v. 55, nos. 1-2, p. 106-117, illus., table, 1970.

Anilite, digenite, and synthetic samples of the composition range $Cu_{1.70}S$-$Cu_{1.82}S$ have been studied by X-ray diffraction and microscopy. At room temperature, the stable phases are djurleite ($Cu_{1.97}S$), anilite ($Cu_{1.75}S$), and covellite (CuS). Above about 70°C, anilite decomposes to high digenite and covellite. The digenite-type solid solution usually appears in synthetic experiments with a composition between $Cu_{1.765}S$ and $Cu_{1.79}S$ at room temperature. The synthesis and crystallographic studies of the digenite-type solid solution indicate that the solid solution is metastable at room temperature and decomposes to mixtures of anilite and djurleite. Natural digenite always contains a small amount of iron and is considered to be stable only in the system Cu-Fe-S. —*from* Authors' abstract

Morris, Gerald B. *See* Helmberger, Donald V. 03507

Morrison, H. F. *See* Coggon, J. H. 03470

Morrison, J. L. *See* Wilson, L. R. 03377

Morrison, Michael F. *See* Northrop, John. 03726

Morse, S. A. *See* Lyons, J. B. 03176

03540 **Mosher, L. Cameron.** New conodont species as Triassic guide fossils: Jour. Paleontology, v. 44, no. 4, p. 737-742, illus., 1970.

Neogondolella regale, *Epigondolella primitia*, and *E. multidentata* are recognized as new conodont species in the Triassic [western North America] with important stratigraphic usefulness. They are guides to zones recognized in, respectively, lower Anisian, upper Karnian-lower Norian, and middle Norian strata. [All three species occur in northeastern British Columbia and Nevada; *E. primitia* has been found in northern California and Austria as well.] An essentially complete evolutionary series has now been recognized in which a continuum of morphologic changes in the Upper Triassic links species of *Paragondolella* and *Epigondolella* and illustrates progressively later retention of juvenile characters (neoteny). — Author's abstract

03710 **Mottana, A.; Edgar, A. D.** The significance of amphibole compositions in the genesis of eclogites: Lithos, v. 3, no. 1, p. 37-49, illus., tables, 1970.

Values of the interaxial angle β distinguish the three major amphiboles found in eclogites — iron-magnesium amphiboles, alkali amphiboles, and calcic amphiboles — while d(100) indicates the cation content in octahedral corrdination (Y) and

atoms with irregular 6- and 8-fold coordination in the X-site. Thus eclogitic amphiboles are subdivided into carinthines under amphibolite facies conditions, glaucophanes in blue-schist facies rocks, hornblendes in granulite facies rocks, and kaersutites in igneous eclogites. — Authors' abstract

Mountjoy, E. W. *See* Price, R. A. 03275

Mower, R. W. *See* Sumsion, C. T. 03063

03398 **Mueller, Robert F.** Energetics of HCl and HF in volcanic emanations: Geochim. et Cosmochim. Acta, v. 34, no. 7, p. 737-744, illus., tables, 1970.

Comparison of the fugacities of HCl and HF calculated from thermochemical data with the abundance of these gases in fumarolic emanations indicates undersaturation of the magma with respect to NaCl, $CaSiO_3$ and Al_2SiO_5 and that the gases have been quenched from magmatic temperatures. — Author's abstract

Munroe, Robert J. *See* Sass, J. H. 03647

03318 **Murrell, S. A. F.; Digby, P. J.** The theory of brittle fracture under triaxial stress conditions, [Pt.] 2: Royal Astron. Soc. Geophys. Jour., v. 19, no. 5, p. 499-512, illus., 1970.

The calculations carried out in Part 1 [1970] of the paper are extended to take acount of cases in which the Griffith cracks are subjected to surface tractions due to (1) fluid pressure, or (2) closure of the cracks under all-round compression. The results are again in broad agreement with results obtained in the two-dimensional treatment of the problem, and with experimental observations. The Mohr envelope in case (2) is a linear one, with a gradient μ_f, where μ_f is the coefficient to Coulomb (sliding) friction. In all cases fracture initiation is shown to be independent of the intermediate principal stress. — Authors' abstract

03337 **Murrmann, R. P.; Reynolds, R. C.; Leggett, D.** Determination of cation exchange capacity of earth materials using a radiotracer technique: U.S. Army Corps Engineers Cold Regions Research and Eng. Lab. Research Report 283, 12 p., illus, tables, 1970.

Two radiochemical methods were investigated for determining cation exchange capacity of earth materials [clay minerals] having a wide range in physicochemical properties. The first attempted was unsuccessful but involved determination of the radioactivity of a 22Na-NaOAc solution in isotopic equilibrium with a Na^+-saturated mineral phase. The method finally adopted is based upon determination of radioactivity of a salt-free, Na^+-saturated mineral sample prepared using a radioactive NaOAc solution with a known 22Na-NaOAc composition. This method is less time-consuming and more accurate than the conventional ammonium acetate method for cation exchange capacity determinations. — *from* Authors' abstract

03194 **Mutschler, Felix E.** Geologic map of the Snowmass Mountain quadrangle, Pitkin and Gunnison Counties, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-853, scale 1:24,000, sections, 1970.

03203 **Narayana Iyengar, R.; Sundara Raja Iyengar, K. T.** Probabilistic response analyses to earthquakes: Am. Soc. Civil Engineers Proc., v. 96, paper 7321, Jour. Eng. Mechanics Div., no. EM 3, p. 207-225, illus., table, 1970.

A statistical response analysis of single degree-of-freedom systems subjected to an earthquake model developed previously has been presented. The investigation includes a detailed study of the variance of the response and an approximate determination of the distribution of the highest peak. The average of this distribution is closely akin to the widely used average response spectra of earthquakes. Detailed numerical results have been presented for four different earthquake-like excitations. — Authors' summary

Nash, Raymond A., Jr. *See* Henrikson, Paul. 03673

03161 **Nash, W. P.; Wilkinson, J. F. G.** Shonkin Sag laccolith, Montana — [Pt.] 1, Mafic minerals and estimates of temperature, pressure, oxygen fugacity, and silica activity: Contr. Mineralogy and Petrology, v. 25, no. 4, p. 241-269, illus., tables, 1970.

In the Shonkin Sag laccolith extreme compositions are represented by a porphyritic pseudolucite-bearing chilled margin, shonkinitic in composition, and a final differentiate, chemically a nepheline syenite. There is no immiscibility gap between the Ca-rich and Na-rich pyroxenes. Olivines changed from Fa_{20} to Fa_{40}, whereas coexisting biotite ranges from $annite_{24}$ to $annite_{100}$; the crystal margins of annites in the most evolved rocks are manganophyllite-rich. Titanomagnetites are TiO_2-poor, and arfvedsonite and melanite occur in the most evolved syenites. At a total vapor pressure of 310 bars, the intrusion temperature was 985°C, and final crystallization was below 700°C; crystallization intervals for most rock types are about 170°C. Silica activity in the melt decreased from 0.13 to 0.09 and oxygen fugacity falls with temperature about parallel to the synthetic fayalite-magnetite-quartz oxygen buffer until olivine disappears. — *from* Authors' abstract

Nassichuk, Walter W. *See* Ross, Charles A. 03643

03196 **National Research Council.** (Committee on Polar Research). Polar research, a survey: Natl. Acad. Sci. [Pub. 1753], 204 p., illus., 1970.

The primary purpose of this report on scientific research in the north and south polar regions is to identify and assess important problems that should be studied in the next few years. Chapter headings are: summary and recommendations, geology and solid-earth geophysics of the polar regions, polar oceans, polar glaciology, glaciology in the Arctic, Antarctic glaciology, snow research and control, polar geodesy and cartography, polar meteorology and climatology, upper-atmosphere physics in the polar regions, polar astronomy, and polar biology and medicine. — MCM

03615 **Neal, William J.** Carbonate facies and paleogeography of the Blackjack Creek Formation (Pennsylvanian), Missouri — Reply to comment by G. W. James [1970] on 1969 paper: Jour. Sed. Petrology, v. 40, no. 2, p. 767-768, 1970.

For the original paper, *see* ibid., v. 39, no. 1, p. 34-48, 1969; Abs. of North American Geology, October 1969.

Nedveckaite, T. N. *See* Styra, B. I. 03221

03532 **Nelson, C. Hans; Carlson, P. R.; Byrne, J. V.; Alpha, Tau Rho.** Development of the Astoria Canyon-Fan physiography and comparison with similar systems: Marine Geology, v. 8, nos. 3-4, p. 259-291, illus., tables, 1970.

The canyon, distinguished by its relief, V-profiles, and numerous tributaries, winds sinuously, and is coincident with structural trends across the shelf. At the fan apex, the canyon mouth merges smoothly into Astoria Channel, with its U-profiles, less relief, and levees. The channel and fan valley appear to have progressively "hooked left," migrated from north to south across the fan, and are partly responsible for the asymmetrical shape of the fan. Similarity of Astoria canyon-fan system with other deep-sea fan and alluvial fan systems suggests the hypothesis that size of drainage basin, sediment size, and sediment load control the size, gradient, and valley development of any fan system. The Astoria fan could have been produced during the Pleistocene and a similar history can be suggested for other major submarine canyon-fan systems. — HRC

03076 **Neuman, Shlomo P.; Witherspoon, Paul A.** Finite element method of analyzing steady seepage with a free surface: Water Resources Research, v. 6, no. 3, p. 889-897, illus., 1970.

A new iterative approach to steady seepage of ground water with a free surface has been developed using the finite element method. This approach eliminates a number of difficulties that were inherent in the iterative procedures previously used to solve this problem and rapid convergence is now assured in all cases. The method is applicable to heterogeneous porous media with complex geometric boundaries and ar-

bitrary degrees of anisotropy. It can handle problems where the free surface is discontinuous and where portions of the free surface are vertical or near vertical. In addition, infiltration or evapotranspiration at the free surface can be handled with ease. Several examples are included to demonstrate the power of this new approach and to show how it can apply to a wider variety of free surface problems than has been possible before. — Authors' abstract

03048 **Newmark, Nathan M.** Current trends in the seismic analysis and design of high-rise structures, Chap. 16 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 403-424, illus., table, 1970.

A general description is given of the response of relatively simple structural systems to earthquake motions, first for elastic and then for inelastic behavior. Generalizations are made about the relation of the response of multidegree-of-freedom systems to simple systems for both elastic and inelastic range, consideration is given to provisions of current building codes for earthquake-resistant design, estimates are made of the required ductility for such buildings, and some comments are made about design of actual buildings and their behavior in earthquakes. — *from* Author's introduction

Ney, C. S. *See* Brown, A. Sutherland. 03464

Nicholls, J. *See* Carmichael, I. S. E. 03177

Nicoll, Robert S. *See* Pollock, Charles A. 03541

03704 **Niedoroda, A. W.; Tanner, W. F.** Preliminary study of transverse bars: Marine Geology, v. 9, no. 1, p. 41-62, illus., 1970.

Transverse bars, normal or nearly so to the beach toe, cause the onshore or offshore transport along bar axes in some cases to be more important than littoral drift. The bar causes refracted wave energy to be increased over the bar and decreased between bars, and bottom friction reduces the wave energy more rapidly over the crest than in the adjacent deeper water, and the result is an onshore current along the axis. This current divides near the breaker zone and returns seaward slowly between the bars. Currents form two meshed gyres of horizontal circulation, one on each side of relatively short transverse bars. Over longer bars, the greater friction reduces the energy so that the between-bar areas provide greater capacity for onshore movement, and the seaward return of this water takes place over the crests of relatively long bars. — HRC

03404 **Nishimura, Susuma.** Disequilibrium of the U-238 series in recent volcanic rocks: Earth and Planetary Sci. Letters, v. 8, no. 4, p. 293-300, illus., tables, 1970.

Concentrations of U-238, Th-230, and Ra-226 are given for recent volcanic rocks from various regions. Disequilibrium observed among U-238 series is interpreted in terms of chemical fractionations occurring during magmatic processes. The fractionation patter, $Ra \geq Th > U$ is observed in Hawaii, the Azores and Japan in oceanic and island arc volcanic regions, and $Th < U$, in the Caucasus, Kamchatka and Italy for continental volcanic regions. — Author's abstract

Noda, Edward K. *See* Wiegel, Robert L. 03719

03269 **Normark, William Raymond.** Growth patterns of deep sea fans [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5169B, 1970.

03477 **Norris, D. K.; Cook, Donald G.; Havard, Christina Jean; Ollerenshaw, Neil C.; Taylor, Gordon C.** Eastern and northern Cordillera, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 693, p. 45-49, 1970.

The area encompassed extends from the 49th parallel to the Arctic Ocean and from the Rocky Mtn. and Tintina trenches to the Plains, and includes the Mackenzie Delta. This part of the Cordillera forms the backbone of the Western Canada sedi-

mentary basin, in which more easterly and younger rocks contain hydrocarbons and coal, and westerly and older rocks contain metallic and industrial minerals. The Phanerozoic section is almost complete and well exposed, and practices established in its study are being used elsewhere. History of solid-earth science activities and the present level of knowledge are reviewed. Future study should include the similarity between the Mackenzie Delta-Arctic Coastal Plain and the Mississippi Delta-Gulf Coast. Practical applications of earth science are mentioned and the most important future trends outlined. Eight recommendations for future work are included. — ESL

03359 **Northrop, John.** Accuracy of earthquake epicenters on the Gorda Ridge: Seismol. Soc. America Bull., v. 60, no. 1, p. 265-267, table, 1970.

An attempt is made to clarify the apparent disparity between the position of earthquake epicenters in the Gorda Ridge area, off the coasts of northern California and Oregon, as shown by Bolt, Lomnitz, and McEvilly (1968), east of the main northerly-trending trough of the ridge, and by Northrop, Menard, and Duennebier (1968), on the crest of the ridge and along the Blanco Fracture Zone. It is suggested that the restricted azimuthal distribution of continental seismograph stations and possible uncertainties in P- and S-wave velocities near the ridge may degrade the accuracy of P-wave determined epicenters in this region. — DBV

03726 **Northrop, John; Morrison, Michael F.; Duennebier, Frederick K.** Seismic slip rate versus sea-floor spreading rate on the Eastern Pacific rise and Pacific Antarctic ridge: Jour. Geophys. Research, v. 75, no. 17, p. 3285-3290, illus., table, 1970.

Slip rates associated with fracture zones were calculated from earthquakes on the Eastern Pacific rise. A total of 2465 earthquakes located by the T-phase network during the period December 1964 through July 1967 were selected for study. Seismic moment was calculated for each earthquake, summed over 1° squares, plotted, and contoured. Comparison of this plot with bathymetric charts of the area shows that: (1) zones of high seismic moment are associated with, but not restricted to, transverse fracture zones; (2) areas of high slip rate are associated with zones of low sea-floor spreading rate; and (3) the Eastern Pacific rise appears to be aseismic between 35°S and 55°S, except near 47°S, 117°W. — Authors' abstract

03498 **Northwood, D. O.; Lewis, D.** Strain induced calcite-aragonite transformation in calcium carbonate: Canadian Mineralogist, v. 10, pt. 2, p. 216-224, illus., tables, 1970.

The transformation of calcite to aragonite by grinding has been studied using X-ray diffraction methods and electron microscopy. Grinding at room temperature produced a partial transformation to aragonite. The transformation curve was characteristic of a nucleation and growth process. It is postulated that the nucleus is formed by atomic movements, produced by microstraining, which generated a small region having the new structure. Various stages have been identified in the deformation of the calcite particles. — Authors' abstract

03143 **Norton, David L.** Uranium geology of the Gulf Coastal area: Corpus Christi Geol. Soc. Bull., v. 10, no. 5, p. 19-26, 1970.

Substantial uranium deposits in the Gulf Coastal Plain are found in at least four formations that range in age from late Eocene to Pliocene. The deposits are in a variety of fluvial sandstone beds including shallow water basins, inshore lagoons, river-channel sandstone beds, and volcanic conglomerate debris. The potential province ranges throughout the western Gulf Coast area. Exploration for deep uranium deposits will require a sophisticated approach to geologic problems which will include relations found among fault belts, salt domes, formation thickness, and geochemical environments in which potential deposits may occur. With sustained technical and financial support over several years, the Gulf Coast is expected to become one of the major uranium producing areas in the United States. — *from* Author's summary

03750 **Norvitch, R. F.; Larson, A. L.** A reconnaissance of the water resources in the Portneuf River basin, Idaho: Idaho Dept. Reclamation Water Inf. Bull. 16, 58 p., illus., tables, 1970.

Major aquifers in the Portneuf River basin are the Tertiary Salt Lake Formation and Quaternary alluvium and basalt. Recent work indicates that the eastern side of the basin is a structural trough that may contain as much as 8,000 feet of sediments whose deposits may contain a tremendous volume of ground water in storage. The major use of water is for irrigation; about 13,500 acres are irrigated with ground water, but there is no evidence that aquifers are being over-developed by pumping. Most water is of the calcium-bicarbonate type. Major items on which future work should focus for a more comprehensive water-resources evaluation are: water budget, hydrologic mapping, hydrology of aquifers, irrigation system, geologic mapping, and special problems. — *from* Authors' abstract

Nota, D. J. G. *See* Loring, D. H. 03707

03202 **Novak, M.** Finite dynamic model for infinite media — Discussion [of paper 6719 by John Lysmer and Roger Kuhlemeyer, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Eng. Mechanics Div., no. EM 2, p. 186-188, illus., 1970.

Paper 6719 was published *in* ibid., v. 95, no. EM 4, p. 859-877, 1969; *see* Abstracts of North American Geology, March 1970.

03660 **Novotny, Oldřich.** Partial dervatives of dispersion curves of Love waves in a layered medium [with German summ.]: Československ. Akad. Věd Studia Geophys. et Geod., v. 14, no. 1, p. 36-50, illus., tables, 1970.

Formulas are derived for calculating the group velocity and partial derivatives of phase and group velocities of Love waves in a layered medium, without application of numerical derivatives. Calculation by means of these formulas is many times faster than by numerical methods, and it is even more precise, particularly in calculating the partial derivatives of group velocity. The partial derivatives of the dispersion curves of Love waves for the model of the Canadian shield are studied in detail. — DBV

Nunan, W. E. *See* Webb, H. W. 03333

Nunzi, A. *See* Fanfani, L. 03168

Nuttli, Otto W. *See* Stauder, William. 03310

03599 **O'Brien, Neal R.; Burrell, D. C.** Mineralogy and distribution of clay size sediment in Glacier Bay, Alaska: Jour. Sed. Petrology, v. 40, no. 2, p. 650-655, illus., 1970.

The mineralogy of clay size bottom sediment was studied in the main channel and adjacent fiords in Glacier Bay, Alaska, to determine if a lateral change in clay composition occurs as sediment is carried from a fresh water to marine environment. X-ray analysis indicates a dominance of chlorite and trioctahedral mica which does not change in composition or abundance laterally. The lack of diagenetic formation of new minerals probably is due to the rapid rate of clay sedimentation and also due to the minor amount of chemical degraduation at the source in the sub-Arctic environment. — Authors' abstract

03181 **Oeschger, H.; Riesen, T.; Lerman, J. C.** Bern radiocarbon dates VII: Radiocarbon, v. 12, no. 2, p. 358-384, 1970.

03325 **Ojakangas, Dennis R.** FORTRAN IV program for simulating geologic development of sedimentary basins: Kansas Geol. Survey Computer Contr. 49, 52 p., illus., tables, 1970.

A FORTRAN IV program is described for simulating geologic processes involved in development of oil traps; deposition, diastrophism, compaction, and erosion can be defined mathematically and structural highs within the three-dimensional model located. Geology of the model area is gridded manually into a regular pattern and described in algebraic terms; time is segmented by defining basement topography and then the geologic events as they are believed to have occurred. Experimentation with different hypotheses may be required to approximate the observed geology.

Visual displays can be specified at any time during the model development, permitting analysis of results before continuing with succeeding events. Displays include listings of geologic columns, structural elevations, and isopachous intervals and CALCOMP-plotted stratigraphic cross sections. — *from* Author's abstract

Okrusch, M. *See* Evans, B. W. 03554

03715 **Okrusch, Martin; Evans, Bernard W.** Minor element relationships in coexisting andalusite and sillimanite: Lithos, v. 3, no. 3, p. 261-268, illus., tables, 1970.

Microprobe analyses of coexisting andalusite and sillimanite in hornfelses from four contact aureoles show that iron is the only impurity element capable of significantly influencing their mutual stability relations. The inclusion of relatively iron-rich pairs establishes the Fe-partitioning as being in favor of andalusite by a factor which lies between 2:1 and 1:1. The resultant stabilization of andalusite relative to sillimanite is geologically rather insignificant. Ferric andalusite is not restricted to pegmatites; pink andalusite from the Steinach aureole, Bavaria, contains up to 3.5 percent Fe_2O_3. The influence of oxygen fugacity on the iron content of the alumino-silicates is clear from examination of the opaque mineralogy. In most zoned andalusites investigated, the ratio Fe in pink to Fe in colorless zones varies between 3:2 and 2:1, but the presence of colour is unrelated to total iron content. — Authors' abstract

Ollerenshaw, Neil C. *See* Norris, D. K. 03477

03407 **Olson, Everett C.** New and little known genera and species of vertebrates from the Lower Permian of Oklahoma: Fieldiana — Geology, v. 18, no. 3, p. 359-434, illus., tables, 1970.

In studies leading to the author's report on Early Permian vertebrates from Oklahoma (1967), many fishes, amphibians and reptiles were collected, parts of which are now in the Stovall Museum at the University of Oklahoma, others at Field Museum in Chicago; specimens were allocated to keep together collections from particular sites and horizons. Review of old materials showed, in new genera and species found, additional information upon previously described but poorly known genera. This paper treats more fully specimens from three important sites described in Olson (1967): Orlando — cricotid amphibian *Cricotillus* and captorhinid reptile *Pleuristion* from the Wellington Formation; Perry site 6 — new araeosceloid reptile *Dictybolos* from the Wellington; and south of Norman — a mixed assemblage of small vertebrates from the Henessey Formation. — GDC

03213 **Olson, Walter S.** Tidal amplitudes in geological history: New York Acad. Sci. Trans., ser. 2, v. 32, no. 2, p. 220-233, illus., tables, 1970.

A poorly understood early Precambrian era is cause for ignoring possible effects of lunar orbital evolution on terrestrial sedimentation and tectonics. Growth bands on fossil invertebrates, back to upper Cambrian, provide a clue to the increasing Earth-Moon distance. In theoretical expression of tidal amplitudes for a world-wide ocean, values in the dominant lunar component differ from actual conditions and observed tides; abnormal tidal paleocurrents are indicated in crossbedding, and suitable parameter may be in thicknesses of littoral conglomerates. Regional examples of these and of tilloids, represent basal units of great marine transgressions in the geologic record; criteria are given for distinguishing them from deep marine turbidity gravels. Proposed tidal amplitudes may produce better models of epeiric sedimentation, explain extent of epicontinental seas and persistent orientation of paleocurrents, and afford new solutions to Precambrian sedimentary problems. — GDC

03534 **Olsson, Richard K.** Paleocene planktonic foraminiferal biostratigraphy and paleozoogeography of New Jersey: Jour. Paleontology, v. 44, no. 4, p. 589-597, illus., 1970.

The Paleocene biostratigraphic zones from lowest to highest include the *Globigerina edita*, *Globorotalia trinidadensis*, *Globorotalia uncinata*, *Globorotalia angulata*, *Globorotalia pusilla pusilla*, *Globorotalia pseudomenardii*, *Globorotalia velascoensis*

Zones. The *G. velascoensis* Zone seems to be only partially developed because of a possible disconformable relation between the Vincentown and Manasquan Formations. The *Globorotalia subbotinae* Zone, lowest Eocene, begins in basal beds of the Manasquan which also contain the *Pseudohastigerina* datum. Widespread uniformity of North Atlantic faunal assemblages in early Paleocene is followed by distinctive latitudinal differentiation in mid-Paleocene; mid- and late Paleocene faunas of New Jersey indicate a distinct temperate paleogeographic faunal province. — *from* Author's abstract

03535 **Olsson, Richard K.** Planktonic Foraminifera from base of Tertiary, Millers Ferry, Alabama: Jour. Paleontology, v. 44, no. 4, p. 598-604, illus., 1970.

The lower few centimeters of the Tertiary (Pine Barren) above Cretaceous (Prairie Bluff) at Millers Ferry, Alabama, contains an assemblage of very small planktonic Foraminifera with largest dimensions of less than 100 microns. These occur in the basal part of the *Globigerina edita* Zone (=*Globorotalia pseudobulloides* Zone) which corresponds in part to the lowest nannofossil zone of the Tertiary, the *Markalius astroporus* Zone. Study of wall structure by scanning electron microscope suggests evolutionary relationships to species higher in the zone and to certain Cretaceous species. This assemblage occurs at a level like that of the central Appenines where Luterbacher and Premoli-Silva (1964) described a thin zone, the *Globigerina eugubina* Zone, of very small planktonic Foraminifera. — *from* Author's abstract

Opdyke, Neil D. *See* Foster, John H. 03729

03520 **Osoba, J. S.; VonGonten, W. D.** Measurement of SP in nonconducting mud: Log Analyst, v. 11, no. 3, p. 3-7, illus., 1970.

As a result of improvements in tools to measure resistivity of the uninvaded zone and porosity of subsurface formations, more accurate interpretation techniques have evolved; however, developments in measurement and utilization of the SP have not kept pace. In the proposed technique for measuring SP in wells with nonconducting fluid, a stream of brine is directed against the wall of the well from a small tank with several gallons capacity; the potential difference between an electrode in the brine and an electrode at the surface connected to the ground is the SP. A cell to measure SP at elevated pressure with nonconducting fluid has been constructed in the laboratory. Laboratory measurements of potential across a shale and across sand with nonconducting fluid against the face of the rock gave essentially the same SP as those obtained in a conventional cell. — *from* Authors' abstract

Ottaviani, Mario. *See* Kuo, John T. 03522

03238 **Ottmann, Liane.** Quelques aspects graphiques de la carte géomorphologique detailée [Several graphic aspects of the detailed geomorphologic map (with English and Russians abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 346-351, illus., 1970.

Four principal categories of data represented on geomorphological maps include: morphologic, morphogenetic, chronologic and geologic. Linear symbols and overall patterns for portraying them are described. Examples of superposition of patterns and of combination with symbols are given. — EH

Owen, J. B. *See* Branson, F. A. 03071

03219 **Owens, Gordon L.** The subsurface Silurian-Devonian "Big Lime" of Ohio: Ohio Div. Geol. Survey Rept. Inv. 75, 17 p., tables, 1970.

"Big Lime," a contraction of "Big Niagaran Lime," refers to a sequence of limestones, dolomites and evaporites of Middle Silurian through Middle Devonian age, present in all of Ohio except for a few counties in the southwestern part of the state. Stratigraphically the "Big Lime" lies beneath the Middle and Upper Devonian Ohio (locally Olentangy) Shale and above the Middle Silurian Rochester Shale. Control data from 785 wells, which are included in a table, were used in constructing the

structure map of the "Big Lime." The isopach map shows a gradual west-to-east increase in thickness of the sequence from <200 to > 2,300 feet in central and eastern Ohio, the differential caused by unconformities on top of and within the sequence. — EH

Oxburgh, E. R. *See* Schubert, Gerald. 03420

03361 **Ozard, J. M.; Russell, R. D.** Discrimination in solid source lead isotope abundance measurement: Earth and Planetary Sci. Letters, v. 8, no. 5,p. 331-336, illus., tables, 1970.

New single rhenium filament lead isotope analyses are presented for which the numerical values of the resulting slopes are $(1.32 \pm 0.04)y/x$ and $(1.53 \pm 0.05)z/x$, respectively. The uncertainties of the slopes are small enough to demonstrate the significance of the differences between observed and theoretical values. This precluded the use of the theoretical fractionation slopes for double spiking with rhenium filaments. It appears that the theoretical slopes serve adequately as the basis for double spike correction of lead isotope data produced with tantalum filaments. It is difficult to postulate a discrimination process that will adequately explain the discrepancy between the observed and predicted slopes. Moreover, it is difficult to know whether the observed discrepancies can be generalized from mass spectrometer to mass spectrometer. — *from* Authors' abstract

03090 **Paeth, Robert Carl.** Genetic and stability relationships of four western Cascade soils [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4461B, 1970.

03676 **Pakiser, L. C.** Structure of Mono Basin, California: Jour. Geophys. Research, v. 75, no. 20, p. 4077-4080, illus., 1970.

Christensen and others [1969] interpreted gravity and seismic data from Mono Basin, Calif., to indicate a basement depth of 1 to 1.5 km, whereas Pakiser and others [1960] and Pakiser [1968] interpreted the same data to indicate a depth of 5 to 5.5 km (with an uncertainty of 1 to 1.5 km). A detailed reexamination of available evidence concerning the geologic structure of the basin indicates that the interpretation by Christensen and others is incompatible with geophysical data, but also that the interpretations of Pakiser and others need revision. The revised interpretation still reveals the presence of a deep fault-bounded depression in the western part of the basin, with a maximum depth to basement (corresponding to a residual gravity anomaly of -50 mgal) somewhat greater than 4.0 km. — DBV

03481 **Palmer, Donald F.** Geology and ore deposits near Benson Mines, New York: Econ. Geology, v. 65, no. 1, p. 31-39, illus., tables, 1970.

The Benson Mines magnetite-hematite deposit is in an iron-rich metasedimentary horizon in a large paragneiss synform now infolded into granite intrusives of the Adirondack highlands. The paragneiss sequence includes pyroxene-quartz-feldspar, biotite-garnet-quartz feldspar, sillimanite-microcline and biotite-quartz-oligoclase gneisses with some skarn lenses. Structural data prove two generations of folding. The first and major was flow folding which imposed mineral lineation on the rocks; the second was flexural slip folding which rotate previous lineations. Petrofabric investigation of magnetic susceptibility anisotropy of magnetite indicates that the ore was affected by the second folding and possibly by the first. In view of impressive conformity of ore to a single horizon in the paragneisses, it is believed to have a metasedimentary origin. — *from* Author's abstract

Palmquist, Robert C. *See* Foster, John D. 03655

Pampeyan, E. H. *See* Tschanz, C. M. 03396

Panteleyev, A. *See* Brown, A. Sutherland. 03464

Papike, J. J. *See* Prewitt, C. T. 03367

03490 **Parham, Walter; Phinney, William; Grant, James.** A teacher's guide for geologic field investigations in the Minnesota River valley: [St. Paul, Minn.] Minnesota Dept. Education, 24 p., illus. [n.d.].

Oldest rocks in the valley are Precambrian, and crop out on the valley floor; metamorphism occurred at 2.6-2.7 and 1.7-2.3 b.y. ago. This basement was deeply weathered before a thin veneer of Cretaceous deposits was laid down. The entire area has up to 300 feet of glacial deposits on the older rocks. The western half of the State was ice-covered in the Pleistocene, and melting of the lobe produced a linear topography of shallow sand-filled channels and low ridges parallel to the Minnesota River. Later, Glacial Lake Agassiz drained into the Minnesota Valley eroding it deeply; when the lake drainage went off to the north, the water volume was so reduced that tributaries deposited their sediments as alluvial fans across the valley forming lakes. In the 15 stops described, the rock types are related to topography, and the origin of the rocks and sediments deduced. — ESL

03594 **Parkash, Barham.** Downcurrent changes in sedimentary structures in Ordovician turbidite greywackes: Jour. Sed. Petrology, v. 40, no. 2, p. 572-590, illus., tables, 1970.

Eight turbidite greywacke beds in the Cloridorme Formation from Gaspé, Quebec were studied. In systematic downcurrent changes along strike from east to west: sole marks change from groove marks, prod marks, and isolated flute marks to longitudinal ridges, longitudinal ridges with overlapping flute marks and closely spaced flute marks, then to poorly-developed longitudinal ridges with occasional cuspate bars, and finally to smooth bottom with occasional groove marks. There is an increase in variance of sole mark directions in the downcurrent direction. Most beds are massive and are divided into two parts by a bedding joint. However, in the proximal region, if a bed is unusually thin, the bedding joint is absent and the bed shows slightly wavy plane-laminated structure. The beds were deposited by relatively low concentration, highly turbulent currents in two distinct phases. — *from* Author's abstract

Parker, Frances L. *See* Berger, Wolfgang H. 03343

Parker, P. L. *See* Attaway, David. 03411

03200 **Parks, James M.** FORTRAN IV program for Q-mode cluster analysis on distance function with printed dendrogram: Kansas Geol. Survey Computer Contr. 46, 32 p., illus., tables, 1970.

Cluster analysis usually begins with a Q-mode sample-by-sample comparison on some measurements of similarity; the resulting N × N similarity matrix is searched repeatedly for pairs or groups of samples exhibiting closest similarities to derive a dendrogram that depicts sample relations in a simple two-dimensional diagram. Although several measures of similarity have been used, only the simple distance function is capable of handling mixed-mode data. After all samples have been clustered, the cluster list is re-sorted for the dendrogram. The sequence of operations for the program are listed, and user's options are discussed. Restrictions and range of the program are: a maxima of 1,000 samples, 200 raw variables, and 10 principal components. The test example is a 12 variable 40 sample subset from a study of Recent carbonate sediments on the Bahamas Platform around Andros Island. — MCM

03401 **Parry, W. T.; Reeves, C. C., Jr.; Leach, J. W.** Oxygen and carbon isotopic composition of West Texas lake carbonates: Geochim. et Cosmochim. Acta, v. 34, no. 7, p. 825-830, illus., table, 1970.

The range in δO-18 (relative to PDB) for fourteen lacustrine dolomites is +5.8 to -3.4 per mil and the range of δC-13 is +5.8 to -3.1 per mil. The range in δO-18 for nine lacustrine calcites is -5.6 to -3.7 per mil and the range in δC-13 is -6.1 to -0.9 per mil. Carbon-14 apparent ages range from 12,200 yr B.P. to over 37,000 yr B.P. — Authors' abstract

Paslay, Paul R. *See* Weidler, Jay B., Jr. 03329

03413 **Patton, William W., Jr.; Miller, Thomas P.** A possible bedrock source for obsidian found in archeological sites in northwestern Alaska: Science, v. 169, no. 3947, p. 760-761, illus., table, 1970.

Recently discovered deposits of obsidian in the Koyukuk Valley may be the long-sought-for source of obsidian found in archeological sites in northwestern Alaska. Obsidian from these deposits compares favorably in physical characteristics and sodium-manganese ratio with the archeological obsidian, and there is evidence that the deposits have been "mined" in the past. — Authors' abstract

03575 **Paul, C. R. C.** The aboral nervous system of *Marsupiocrinus* Morris: Fieldiana — Geology, v. 16, no. 18, p. 461-469, illus., 1970.

This crinoid specimen came from the Silurian Brownsport Formation of Decatur County, Tenn. The plates are either deeply weathered or were split irregularly when the specimen broke free, and an unusual branching structure which was entirely within the calycal plates, is revealed. This position suggests that it may have been part of the aboral nerve system, but the structure, described at some length, is radically different from that of recent crinoids. This difference suggests that the structure represents some other organ system not found in recent crinoids, or that the function of the aboral nerve system was not exactly the same in fossil camerates as in recent crinoids. — ESL

Paul, Richard R. *See* Archbold, N. L. 03217

03395 **Pautot, Guy; Auzende, Jean-Marie; LePichon, Xavier.** Continuous deep sea salt layer along North Atlantic margins related to early phase of rifting: Nature, v. 227, no. 5256, p. 351-354, illus., 1970.

Deep seismic reflection surveys have revealed diapiric structures in deep water off Labrador, Newfoundland, Mauritania, Morocco, Portugal, Spain and Ireland as well as in the Mediterranean. Many of these diapirs are similar to the Gulf of Mexico salt domes, and it is suggested that there is a continuous deep-sea salt layer, off the continental margin, which is related to the early phase of rifting. — Authors' abstract

Pavelka, B. R. *See* Crippen, J. R. 03056

Pelletier, Bernard R. *See* Swift, Donald J. P. 03745

03316 **Pelletier, Jean.** Le relief du massif des Adirondacks—Pt. 1, Étude preliminaire [The relief of the Adirondack massif—Pt. 1, Preliminary study (with English and German abs.): Rev. Géographie Montréal, v. 24, no. 1, p. 65-78, illus., 1970.

Research was initiated three years ago on the Adirondack massif, a roughly triangular area in horizontal section bordered by the Mohawk and St. Lawrence Rivers, and the Hudson-Champlain trough; Mt. Marcy, the highest peak, is about 1,625 m high. The general outline of the massif is a large faulted monoclinal earth block. Two points to be discussed more fully in further articles are: the role of differential erosion in the process or arrangement of the relief masses, and the clear-cut style of the NNE and SE margins of the massif. Several detailed examples indicate that the role of the former erosional processes is important, thus posing the problem of the climates under which these processes have progressed; the general aspect of the margins is characterized mainly at the periphery by important and numerous tectonic breaks without any visible classical cuesta contact in the sedimentary margin. — *from* Author's English abstract

Penley, H. M. *See* Webb, H. W. 03333

03447 **Penzien, Joseph.** Soil-pile foundation interaction, Chap. 14 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 349-381, illus., 1970.

A general method is presented for investigating the seismic effects on bridges that are supported on long piles extending through deep, sensitive clays. The analysis was

made primarily for application to the construction of a bridge across Elkhorn Slough near Monterey, Calif. The analysis is in two parts: (1) determination of dynamic response of the clay medium alone when excited through its lower boundary by horizontal seismic motion, and (2) determination of the interaction of the entire structural system, including piles, with the moving clay medium. Application of the method to design of the Elkhorn Slough bridge is presented in detail. — VSN

03317 **Perlmutter, N. M.; Lieber, Maxim.** Dispersal of plating wastes and sewage contaminants in ground water and surface water, South Farmingdale-Massapequa area, Nassau County, New York: U.S. Geol. Survey Water-Supply Paper 1879-G, p. G1-G67, illus., tables, 1970.

This study compares dispersal of heavy-metal ions discharged into ground water in the metal-plating-waste effluent from an industrial plant, with dispersal of detergents from several hundred domestic cesspools and septic tanks. The contaminated ground water is moving through highly permeable beds of sand and gravel of the upper glacial aquifer. The quality of water in the underlying Magothy aquifer is apparently unaffected. Plating wastes containing cadmium and hexavalent chromium have seeped into the upper aquifer since 1941, but concentrations of contaminants have gradually decreased and no public-supply wells are contaminated. The detergent constituent, alkybenzenesulfonate, or methylene blue active substance, chiefly concentrated in the upper 20 feet of the upper aquifer, occurs as deep as 70 feet below the water table near the bottom of the aquifer, but has not seeped into the Magothy aquifer. — *from* Author's abstract

03493 **Perrault, Guy.** La minéralogie de nos jours à l'an 2000 [The mineralogy of our days to the year 2000]: Canadian Mineralogist, v. 10, pt. 2, p. 151-162, 1970.

The lives of a number of mineralogists and crystallographers in the past are reviewed. These men have discovered important fundamental laws which might have escaped the attention of physicists and engineers. The section on present technology and future prospects is divided into the rapid growth of scientific knowledge, analysis of published information, "ordinateurs," scientific instrumentation, and mineral species. Perrault believes that important discoveries will be made in two fields: the relation between structure and thermodynamic products in minerals, and crystal chemistry and crystal physics. A final section is devoted to applied and fundamental science. — ESL

03711 **Petersilie, I. A.; Sörensen, H.** Hydrocarbon gases and bituminous substances in rocks from the Ilímaussaq alkaline intrusion, South Greenland (Contribution to the mineralogy of Ilímaussaq No. 18): Lithos, v. 3, no. 1, p. 59-76, illus., tables, 1970; *reprinted as* Grönlands Geol. Undersögelse Misc. Paper 76, 1970.

Samples of poikilitic sodalite syenite (naujaite), sodalite foyaite and augite syenite from the Ilímaussaq alkaline intrusion in South Greenland contain hydrocarbons in vacuoles in the minerals and in intergranular micro-pores. Samples of lujavrite and gabbro have very low gas contents. Methane is the predominant hydrocarbon; the contents of CO_2 and CO are insignificant. The carbon of the hydrocarbon gases of naujaite is enriched in C^{13}. The rocks contain disseminated bituminous substances composed mainly of oil, alcohol-benzol resins and asphaltenes. The hydrocarbon gases and the bituminous substances are thought to be of inorganic origin. The methods of examination are described. — Authors' abstract

Peterson, Donald L. *See* Kleinkopf, M. Dean. 03472

Peterson, Etta. *See* Kvenvolden, Keith A. 03164

03144 **Peterson, W. A.** Uranium on horseback, or South Texas revisited: Corpus Christi Geol. Soc. Bull., v. 10, no. 5, p. 5-10, 11A-17, illus., 1970.

In 1968 mineral explorers flocked back to South Texas for another look at the Tertiary sedimentary prism between the Jackson and Goliad formations. In a trend belt 200 × 50 mi, uranium was discovered in quantities to challenge established districts in the

Colorado Plateau and Wyoming. In trying to set the complex uranium phenomenon in a simple framework, not the least part of the dilemma is the coincidence(?) of oil-field structural features with the occurrence of ore. Despite some inexactitude, the prospector today brings to uranium exploration refinements in tools and techniques which leave little to chance that significant mineralization will be overlooked. Oil companies have moved vigorously into the uranium play, confident that the familiar, relatively shallow sediments offer excellent profit opportunity, and future industrial growth. — *from* Author's abstract

03430 **Petit, Richard E.** Notes on Cancellariidae (Mollusca: Gastropoda), [Pt.] 2: Tulane Studies Geology and Paleontology, v. 8, no. 2, p. 83-88, illus., 1970.

A new cancellariid genus *Olssonella* is described, with type species designated as *Cancellaria smithii* Dall, 1888, Holocene, western Atlantic Ocean. A total of 12 species considered to belong to the new genus are listed, including *O. vokesae* n.sp., early Miocene "Silverdale beds," Onslow County, N.C., which is described here; the other species listed were placed formerly under *Cancellaria* and *Trigonostoma* and most of them occur in the Neogene of southeastern U.S. and the Caribbean region. *Charcolleria distinguenda* n.sp. is described from the early Miocene Chipola Formation, Calhoun County, Fla. Two new living species are described from Galapagos Islands, and two new names are proposed for living species. — VMJ

03494 **Petruk, W.; Cabri, L. J.; Harris, D. C.; Stewart, J. M.; Clark, L. A.** Allargentum, redefined: Canadian Mineralogist, v. 10, pt. 2, p. 163-172, illus., tables, 1970.

The name allargentum for the ϵ-phase of the Ag-Sb system had been proposed by Ramdohr, but due to lack of compositional knowledge and X-ray diffraction data of the type material, the name was applied to a variety of silver rather than to the natural occurrence of the ϵ-phase. This led to confusing interpretations of Ag-Sb assemblages. A recent detailed study of samples from the Cobalt area has permitted a reappraisal. Allargentum is now redefined as the natural occurring equivalent of the ϵ-phase of the Ag-Sb system usually containing some mercury. It has a hexagonal close-packed structure with $a = 2.95$A and $c = 4.77$A, $Z = 2$, calculated s.g. = 0.12, and unit cell formula $Ag_{0.86}Sb_{0.14}$. It is weakly anisotropic under crossed nicols, reflectivity is less than that of silver, and its microhardness is 189 kg/mm². — *from* Authors' abstract

Péwé, T. L. *See* Updike, R. G. 03371

Philberth, K. *See* Federer, B. 03644

03127 **Phillips, Brian A. M.** Effective levels of marine planation on raised and present rock platforms [with French and German abs.]: Rev. Geographie Montreal, v. 24, no. 3, p. 227-240, illus., 1970.

Questions are raised as to the role played by raised shorelines in interpreting Pleistocene paleogeography. The present level of effective marine planation is shown to be most variable in range and location, and it is found that the modern tidal foreshore owes much of its apparently youthful form to inheritance from a previous period of similar sea-level. Work in part of western Britain demonstrates that though separate raised shore platforms are defined, the range of elevation of their remnant notch heights overlaps to a variable degree. Superimposition of successive sea margins during the Pleistocene has resulted in a complexity of present coastal forms in which the interpretation of raised shoreline remnants will only be valid if the implications derived from study of present processes are applied. — *from* Author's abstract

Phinney, R. A. *See* Knopoff, L. 03679

Phinney, William. *See* Parham, Walter. 03490

03487 **Phinney, William C.** (editor). A teacher's guide for geologic field investigations in Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, sections paged separately [n.d.].

Guides for different areas of the state have been printed in eight separately bound volumes which are cited separately. Each guide begins with a brief introduction to the regional geology and proceeds to specific stops which can be used to illustrate one or more problems. There are suggested questions and activities for each stop. — ESL

03604 **Picard, M. Dane; High, Lee R., Jr.** Interference ripple marks formed by ephemeral streams: Jour. Sed. Petrology, v. 40, no. 2, p. 708-711, illus., table, 1970.

Interference ripple marks form during floods along many ephemeral streams. Cuspate (linguoid) ripples form first when flood water in the channel is deep enough to flow over marginal and channel sand bars. As the water level falls, downstream currents are refracted shoreward over the marginal sand bars and linear ripple sets are formed on the tops and flanks of the bars. The linear ripples are oriented at right angles to the cuspate ripples and commonly form interference sets with them. On the basis of study of modern ephemeral streams, we conclude that paleocurrent patterns of fluvial deposits are probably more complex than has generally been recognized. Still, the distribution of directional structures in modern streams is, in general, unimodal, and the dominant inclinations of foreset laminae are downstream. — *from* Authors' abstract

03748 **Pierce, J. W.; Colquhoun, D. J.** Configuration of the Holocene primary barrier chain, Outer Banks, North Carolina: Southeastern Geology, v. 11, no. 4, p. 231-236, illus., 1970.

The presence of a well-developed soil zone under parts of the Outer Banks and its absence under other parts permit a reconstruction of the initial shape of the coastline during the latter part of the Holocene rise in sea level to near its present level. The primary barrier lay to the east of the present coast in places and to the west of the present shore in others. The present coastline has developed from this original shape. — Authors' abstract

Pilkey, Orrin H. *See* Field, Michael. 03389

Pilkey, Orrin H. *See* Judd, James B. 03721

Pinder, G. F. *See* Bredehoeft, J. D. 03075

03074 **Pinder, George F.; Cooper, Hilton H., Jr.** A numerical technique for calculating the transient position of the saltwater front: Water Resources Research, v. 6, no. 3, p. 875-882, illus., 1970.

The movement of the saltwater front in coastal aquifers, including the effect of dispersion, can be determined by using numerical methods. The method of characteristics is used to solve the solute transport equation, and the alternating direction iterative procedure is used to solve the groundwater flow equation for the two-dimensional problem. This approach permits the treatment of transient flow in non-homogeneous aquifers with irregular geometry. — Authors' abstract

03686 **Pingitore, Nicholas E., Jr.** Diagenesis and porosity modification in *Acropora palmata*, Pleistocene of Barbados, West Indies: Jour. Sed. Petrology, v. 40, no. 2, p. 712-721, illus., table, 1970.

The mineralogy and petrography of a single coral species, *Acropora palmata* [from uplifted coral reefs of Barbados], was examined in detail. Post-depositional modifications of the coral skeleton included entrapment of lime sand and mud, precipitation of void-filling aragonite needles in the marine environment, solution of the coral, alteration from aragonite to calcite skeletal mineralogy, and precipitation of calcite cement. The precipitation of calcite cement is volumetrically the most important porosity alteration. The source of this void-filling cement is shown to be the excess material remaining after the volume solution of aragonite skeleton and reprecipitation of calcite when the coral skeleton equilibrates mineralogically to the subaerial environment. — *from* Author's abstract

03652 **Piper, D. J. W.** Transport and deposition of Holocene sediment on La Jolla deep sea fan, California: Marine Geology, v. 8, nos. 3-4, p. 221-227, illus., tables, 1970.

Sediment distribution on the fan is related to processes acting along the fan valley. Holocene sediments are sands with interbedded muds; a few of the muds are in thin beds in which the low sand content is graded. All other muds are bioturbated. Structures in the sands suggest deposition by strong currents of gradually declining competence carrying large amounts of suspended sediments, and thought to be turbidity currents. The Holocene sediments on the fan are about 2 m thick, indicating that about 90 percent of the sediments being supplied to the canyon is bypassing the fan. — *from* Author's abstract

Pirie, R. Gordon. *See* Swift, Donald J. P. 03292

03480 **Pirkle, E. C.; Yoho, W. H.** The heavy mineral ore body of Trail Ridge, Florida: Econ. Geology, v. 65, no. 1, p. 17-30, illus., tables, 1970.

Trail Ridge in southern Georgia and northern Florida is a broad sand ridge with north-south length of 125 mi. The most widespread concentrations of heavy minerals are along a 17-mi stretch at the southern end; evidence indicates that this part was formed along an old shore line bordering northern Lake Wales Ridge. Younger ridges parallel Trail Ridge in the latitude of the ore, and some have been confused with Trail Ridge. Other concepts proposed to explain Trail and Lake Wales Ridges are discussed in light of currently available data. It is concluded that they are not parts of the same ridge. The possibility that Trail Ridge is a residual sand ridge formed by weathering of sediments *in situ* is inconsistent with characteristics of sediments and field relation, and the idea that it is a barrier island is also inconsistent with present data. — *from* Authors' abstract

03091 **Pissarides, Andreas Savva.** The interaction of phosphate with hydroxy-aluminum interlayers of montmorillonite [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4462B, 1970.

Pitt, Andrew M. *See* Stauder, William. 03311

03595 **Pittman, Edward D.** Plagioclase feldspar as an indicator of provenance in sedimentary rocks: Jour. Sed. Petrology, v. 40, no. 2, p. 591-598, illus., table, 1970.

A technique utilizing a petrographic microscope with a flat stage for analysis of provenance has been developed. Procedure is to concentrate feldspar in the medium or coarser sand range by flotation techniques, then to separate this concentrate by means of heavy liquids into potash feldspar, albite, oligoclase-andesine, and calcic plagioclase. Thin sections of these plagioclase separations are examined for twin characteristics (C-twins, A-twins, and untwinned), and zoning characteristics (progressive, oscillatory, and unzoned). This leads to inferences about the presence of metamorphic plutonic, igneous, or volcanic-hypabyssal rocks in the source area. Only the predominant rock type usually can be detected. An exception to this is volcanic and hypabyssal rocks, which commonly yield plagioclase with diagnostic properties. — Author's abstract

03366 **Podosek, F. A.; Hohenberg, C. M.** I-Xe dating, evidence for cold assembly of an unequilibrated chondrite: Earth and Planetary Sci. Letters, v. 8, no. 6, p. 443-447, illus., table, 1970.

Essentially all of the more equlibrated meteorites which contain excess radiogenic Xi-129 have well-defined I-Xe formation intervals that apparently date the onset of proportional retention for iodine and radiogenic Xe-129 from the decay of I-129. Precise data on the unequilibrated chondrite Manych, which contains large excesses of Xe-129, clearly demonstrate a lack of correlation between the radiogenic Xe-129 and iodine. Although this effect might be accounted for by other mechanisms, it can also be interpreted as evidence for the cold accretion of constituent parts, some of which may have retained the I-Xe record of a previous history. Re-examination of data from the unequilibrated chondrites Chainpur and Renazzo tend to support such an interpretation. — Authors' abstract

03019 **Poirier, Jean.** Fente de gel fossile aux Îles-de-la-Madeleine, Québec [A fossil ice wedge at Iles-de-la-Madeleine, Quebec (with English and Russian abs.)]: Rev. Géographie Montréal, v. 24, no. 3, p. 319-320, illus., 1970.

A fossil ice wedge, found near Havre-Aubert, Îles-de-la-Madeleine, Quebec, is described. — EH

Pollack, Henry N. *See* Levy, Michael A. 03312

03541 **Pollock, Charles A.; Rexroad, Carl B.; Nicoll, Robert S.** Lower Silurian conodonts from northern Michigan and Ontario: Jour. Paleontology, v. 44, no. 4, p. 743-764, illus., table, 1970.

Conodonts representing 50 species, 8 new, from 19 genera, one new, were collected from 15 outcrop sections and a core of Lower Silurian rocks in the northern peninsula of Michigan and in [southern] Ontario. New taxa include the genus *Exochognathus* and the following species: *Ambalodus anapetus*, *Aphelognathus siluricus*, *Exochognathus keislognathoides*, *Icriodella discreta*, *Spathognathodus comptus*, *S. elibatus*, *S. hassi*, *S. manitoulinensis*. The conodont zone between the top of the Ordovician and the base of the *Icriodina irregularis* Assemblage Zone is named the *Panderodus simplex* Assemblage Zone. — Authors' abstract

Pomeroy, Paul W. *See* Liebermann, Robert C. 03025

Pomeroy, Paul W. *See* Levy, Michael A. 03312

03569 **Poole, W. H.** Solid-earth science in the Appalachian region of Canada, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 204-213, 1970.

Geological investigation began more than 150 years ago in the Appalachians of Canada. The distribution of formations, and their ages and structures are known to 1- or 2-mile scale. Most Newfoundland geology is known only to 4-mile scale. Increased activity is needed toward regional analyses and problem studies through the efforts of multidisciplinary teams. The ultimate objectives must be discovery and development of mineral resources and use and conservation of natural materials. The increase and broadening of communication among Appalachian scientists is recommended, specifically those in the Atlantic provinces. It is proposed that an Appalachian Division of the Geol. Assoc. of Canada be formed, and also a committee or council to examine the state of the science in the region, to identify programs and individual projects of research, and to make recommendations. — *from* Author's abstract

Porter, S. C. *See* Denton, G. H. 03157

03240 **Pratt, C. J.** Sulfur: Sci. American, v. 222, no. 5, p. 62-72, illus., 1970.

This popular article summarizes the origin and distribution of world-wide sulfur deposits as well as the techniques of recovery, use, supply and demand. — DWR

03367 **Prewitt, C. T.; Papike, J. J.; Ross, Malcolm.** Cummingtonite, a reversible, nonquenchable transition from $P2_1/m$ to $C2/m$ symmetry: Earth and Planetary Sci. Letters, v. 8, no. 6, p. 448-450, illus., 1970.

Cummingtonite from the Gouverneur, New York, talc district with space group $P2_1/m$ has been used in a high-temperature, single-crystal, X-ray diffraction study. When diffraction patterns are taken of the crystals heated in a sealed silica capillary to 45°C or higher, these reflections disappear, indicating a transition to $C2/m$ symmetry. The transition appears to be analagous to the $P2_1/c$ to $C2/c$ transition between 700° and 800°C discovered recently in $(Mg_{0.30}Fe_{0.70})SiO_3$ clinopyroxene. In addition to the cummingtonite transition, we have also found a transition in pigeonite at higher temperatures. The transition occurs in pigeonite (Gunflint Iron Formation, Minnesota) at about 670°C. This is a significantly lower temperature than was found for the Ca-poor clinopyroxene. — *from* Authors' abstract

Price, P. Buford. *See* Ahrens, Thomas J. 03363

03275 **Price, R. A.; Mountjoy, E. W.** Geologic structure of the Canadian Rocky Mountains between Bow and Athabasca Rivers — A progress report, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 7-25, illus., geol. map, 1970.

In this outline of the structure of part of the Rocky Mountains within Canada, the fundamental genetic relationship between the Rocky Mountains and the rest of the Cordillera, and the important role that data from the Rocky Mountains can play in elucidating the structural evolution of the whole Cordillera are emphasized. — EH

Prill, Robert. *See* Green, Don W. 03073

Prolss, G. W. *See* Weaver, P. F. 03158

Pyke, D. R. *See* Middleton, R. S. 03460

Pytkowicz, R. M. *See* Culberson, Charles. 03293

03400 **Pytkowicz, R. M.** On the carbonate compensation depth in the Pacific Ocean: Geochim. et Cosmochim. Acta, v. 34, no. 7, p. 836-839, illus., tables, 1970.

Calcium carbonate is shown to be present in Pacific Ocean sediments which underlie undersaturated waters and, therefore, the presence or absence of sedimentary carbonates is not simply due to a transition from supersaturated to undersaturated waters, but is controlled by rate-limiting factors. — Author's abstract

03517 **Quebec Dept. Natural Resources.** Field work in 1968, summary of results [also French edition]: Quebec, Quebec Dept. Nat. Resources (S-115), 48 p., illus., 1970.

Summaries of results of the technical field program carried out during 1968 by the Geological Services are accompanied by a map showing general location of each of 23 parties for field mapping and other studies in specific areas. Emphasis was primarily on mapping projects, although there were other areal studies as well as alluvial prospecting, drill-core logging, and geophysical tests. The Mineral Deposits Service projects were divided between the Geology, Industrial Minerals and Building Materials, Peat Bogs, and Natural Gas and Petroleum Divisions, and the Resident Geologists for the three districts. The Hydrogeology Service was engaged in eight projects. The individual summaries are not cited separately. — MCM

03656 **Qutub, Musa.** Hydrogeology of the northeast quarter of Marion County, Iowa: Iowa Acad. Sci. Proc. 1969, v. 76, p. 311-319, illus., table, 1970.

In the surveys conducted during the year of 1965-66, the bedrock topography was found to be an extremely irregular surface, and composed of both Mississippian and Pennsylvanian rocks. The top of the Mississippian rocks was an irregular erosional surface possibly indicative of karst topography. The piezometric surface for wells cased in Mississippian strata indicates a ground water divide; north of this divide water flows into South Skunk River, and south of the divide into Des Moines River. The quality of the ground water deteriorated with depth, due to the coal and pyrite in Pennsylvanian strata, and limestone, dolomite, and some gypsum in Mississippian strata. The principal aquifers as far as the production of wells is concerned are the St. Louis and Ste-Genevieve Formations and the Pleistocene deposits. — *from* Author's abstract

03439 **Rabchevsky, George A.** Remote sensing of the earth's surface — Pt. 1, Fundamentals of remote sensing: Jour. Remote Sensing, v. 1, no. 3, p. 15-17, illus., 1970.

Aerial photographs of the earth's surface are considered to be the earliest of remote sensor data. One hundred and twelve years have passed since the first of such photographs was taken from a balloon. During this period, massive amounts of literature have accumulated that deal with the various phases of remote sensing techniques, interpretations, and applications. This paper was compiled from existing literature on remote sensing and is intended to present the state-of-the-art on this subject. — Author's abstract

Ragland, P. C. *See* Dietrich, R. V. 03749

03703 **Ragland, Paul C.** Composition and structural state of the potassic phase in perthites as related to petrogenesis of a granitic pluton: Lithos, v. 3, no. 2, p. 167-189, illus., tables, 1970.

Variations in composition and structural state of the potassic phase in perthites from a granitic pluton are controlled by distribution of water. Sixty microcline perthites from the Precambrian Enchanted Rock batholith, Texas, were investigated by X-ray and optics, using three measures of structural state: obliquity, optic angle, and a parameter defined by Wright's 'three-peak method.' Perthite phenocrysts from the intermediate-central zone contain co-existing orthoclase and intermediate microcline, whereas near-maximum microcline predominates in K-feldspars from other lithologic zones. Degree of ordering correlates positively with differentiation index, as well as percent Or of potassic phase. Estimates on water fugacities based upon biotite compositions agree with the proposed model of catalysis by water and its effect on inversion and unmixing of constituent alkali feldspars. — *from* Author's abstract

Ramanatha Iyer, T. S. *See* Andersland, Orlando B. 03027

03288 **Rankin, D.; Reddy, I. K.** Polarization of the magneto-telluric fields over an anisotropic earth: Pure and Appl. Geophysics, v. 78, p. 58-65, illus., 1970.

The effect of an anisotropic earth on an elliptically polarized incident magnetic field is investigated. A new method is developed for delineating the local conductivity structure using the polarization parameters of the magneto-telluric fields. — Authors' summary

Rankin, John G. *See* Sackett, William M. 03563

03087 **Rao, S. V. L. N.; Lahiri, A.** Concordance between trend maps: Modern Geology, v. 1, no. 3, p. 219-236, illus., tables, 1970.

Principal axis analyses have been carried out for trend and residual surfaces, up to fourth order, of two simulated models. Since the principal axes of a surface are directly dependent on the generated polynomial which approximates to the trend component of the variable parameter, it is suggested that they may be used for the comparison of subset trend maps and for characterization of trend surfaces. — Authors' abstract

03521 **Raymer, L. L.; Salisch, H. A.** The contribution of flushed zone measurements to formation evaluation: Log Analyst, v. 11, no. 3, p. 17-25, illus., tables, 1970.

The importance of flushed-zone measurements to improve formation evaluation in shaly and heterogeneous rocks and in clean formations is illustrated by field examples. Logs of acoustical velocity, bulk density, and neutron hydrogen index are flushed-zone measurements from which the porosity, lithology, and shaliness can be evaluated, and frequently also, the nature of the hydrocarbon phase can be predicted. A shallow resistivity measurement of the flushed zone is valuable for improvement of lithology and porosity interpretations in hydrocarbon-bearing formations, for evaluation of hydrocarbon movability and for selection of optimum completion levels. This technique is particularly needed in low-porosity formations, heterogeneous rocks, or in reservoirs containing viscous oils. As shown by examples, combinations of these logs can contribute significantly to determination of formation type, fluid content, and hydrocarbon producibility. — *from* Authors' abstract

Rebagay, T. V. *See* Ehmann, W. D. 03550

Reddy, I. K. *See* Rankin, D. 03288

03241 **Reed, John C.** Oil developments in Alaska: Polar Rec., v. 15, no. 94, p. 7-17, illus., 1970.

The Prudhoe Bay oil strike of 1968 triggered a boom exceeding early gold rushes. Potential oil- and gas-bearing rocks. Mississippian through Cretaceous and some Tertiary, fill a huge geosyncline, with a basement of complex Brooks Range rocks. Over all is recent silt, the 100 m-thick Gubik formation, almost solidly frozen because of permafrost at least 400 m thick. Some interest still lies in the Pacific coast area of first brief oil production (1930) and in the Gulf of Alaska. The U.S. Naval Pet 4 program, 1944-53, developed methods for large-scale operations under difficult or hazardous arctic conditions. Estimated reserves of 5 to 10 billion bbls of oil for the present seismic interpreted structure, its sand characteristics shown by the productive interval in two wells, may be too low; re-evaluation includes 0.72 trillion cu m of gas. In development, the most important problem is transportation. — GDC

03276 **Reesor, J. E.** Some aspects of structural evolution and regional setting in part of the Shuswap metamorphic complex, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 73-86, illus., table, 1970.

The Shuswap metamorphic complex is a narrow belt of high-grade metamorphic rocks in the eastern Cordilleran fold belt in southeastern British Columbia, characterized by regional metamorphism in the upper amphibolite facies. In the eastern part are a series of gneiss domes at about 40-50-mi intervals along the length of the complex, featured by migmatitic granitoid rocks in core zones enveloped by mantles of metasedimentary gneiss. Other typical structures in the gneisses are northward-verging folds with west-southwest or westerly trend and up to several thousand feet of amplitude. Many mesoscopic structures show contrasting styles in core zone and mantling gneisses. The positions of gneiss domes are determined at the earliest stage of deformation recognized in the gneiss complex and may be related to culminations of large north-verging, east-west folds and coincident culminations in the thermal structures. — *from* Author's abstract

Reeves, C. C., Jr. *See* Parry, W. T. 03401

03285 **Reeves, Robert G.** Working geologists compare training and needs: Geotimes, v. 15, no. 4 [!5], p. 16, 1970.

Results of a questionnaire sent to a sample of the 30,000 practicing geologists in the United States, who received bachelor's degrees between 1961 and 1966, were compared with statistics on practicing geologists from the Natl. Register of Scientific and Technical Personnel. For each of 290 items the following questions were asked: (1) how valuable is knowledge of this item in your work? (2) is your competence sufficient for your current work? and (3) what value will, or could, knowledge of this item be to you in the future? Responses were punched on cards for computer processing, and summary data are stored on magnetic tape, copies of which are available. A comprehensive report is being published as CEGS Programs Pub. 5, Requirements in the Field of Geology. Solicited comments stress a need for basic science and mathematics, principles of geology, and ability to communicate. — ESL

Reid, W. E. *See* Wilson, L. R. 03377

03533 **Reimnitz, Erk; Gutiérrez-Estrada, Mario.** Rapid changes in the head of the Rio Balsas submarine canyon system, Mexico: Marine Geology, v. 8, nos. 3-4, p. 245-258, illus., 1970.

One of the distributaries of the Rio Balsas is discharging into the head of Cañón de la Necesidad, which is being eroded actively. Two inactive canyons are related to former discharge channels of the river. The Cañón de Petacalco, not now receiving sediment directly from a Rio Balsas distributary, has remained active because the shoreline has not retreated far. The changes in the shallow portions of the Rio Balsas submarine canyons seem to be related to changes in the river discharge pattern, either directly or indirectly. The heads of the different distributaries form a dendritic pattern in Holocene sediments; subaerial processes are not involved in the formation of these canyons so that a dendritic pattern of submarine canyons is not necessarily indicative of subaerial erosion. — *from* Authors' abstract

03350 **Reiter, Leon.** An investigation into the time term method in refraction seismology: Seismol. Soc. America Bull., v. 60, no. 1, p. 1-13, illus., tables, 1970.

The time term method of seismic refraction data analysis was investigated analytically and through numerical experiments. Error terms for computed refractor depths, derived for two site arrays over a simple dipping refractor surface and a symmetric anticlinal refractor surface, proved to be qualitatively reliable guides to performance of the time term method using models of multisite arrays over planar and biplanar refractor structures. Neither continuity of time terms nor use of a known refractor velocity in the computations guaranteed a more accurate refractor reconstruction. In the two models tested a refractor velocity greater than the true velocity yielded the best reconstruction. If the structure has refractor surfaces dipping more than a few degrees, the time term method will give inaccurate results. — *from* Author's abstract

Rexroad, Carl B. *See* Pollock, Charles A. 03541

Reynolds, R. C. *See* Murrmann, R. P. 03337

03119 **Reynolds, Robert C., Jr.; Hower, John.** The nature of interlayering in mixed-layer illite-montmorillonites [with French, German and Russian abs.]: Clays and Clay Minerals, v. 18, no. 1, p. 25-36, illus., tables, 1970.

The nature of interlayering was investigated by comparison of diffraction patterns of samples treated with ethylene glycol and ethylene glycol monoethyl ether with calculated one-dimensional diffraction profiles. The latter take into account effects of particle size distribution, composition, and convolution factors as well as proportions of layers and interstratification type. It is concluded that there are three types of interstratification — random, allevardite-like ordering, and superlattice units with three illite and one montmorillonite layers; that almost all illite-montmorillonites with expandibilities from 40 to 100 percent are randomly interstratified, allevardite excepted; and that at < 40 percent montmorillonite layers, they almost always have ordered interstratification. Allevardite-like ordering predominates in ordered illite-montmorillonites, with the superlattice varieties confined to samples with about 10 percent montmorillonite layers. — *from* Authors' abstract

03126 **Richard, Pierre.** L'analyse pollinique au Québec — Mise au point et tendances actuelles [Palynology in Quebec — Observations on its development and present trends (with English and German abs.)]: Rev. Géographie Montréal, v. 24, no. 2, p. 189-197, illus., 1970.

Palynological works, initiated in Quebec by Auer in 1930, have been carried on by Bowman, Radforth, Wenner, and especially by Potzger (assisted by Courtemanche) whose name is closely connected to the first palynological studies covering almost all Quebec. More recently new works have been issued by Ignatius, Grayson, Legault, and especially Terasmae. The article assesses these studies from the point of view of new notions in palynology as well as of new techniques and methods of interpretation. Careful identification of pollens is still the best means of getting detailed paleobiogeographical data and information. An interpretation methodology based on an analytical use of subpresent time pollinic rain data by vegetation unit is presented. — *from* Author's English abstract

Richards, Thomas. *See* Sainsbury, C. L. 03334

Richardson, J. *See* Allen, J. M. 03465

03511 **Richter, C. F.** Magnitude of the Inglewood, California, earthquake of June 21, 1920: Seismol. Soc. America Bull., v. 60, no. 2, p. 647-649, table, 1970.

Comparison with later earthquakes in the same area indicates a magnitude near 4.9 for the Inglewood, Calif. earthquake of June 21, 1920. — Author's abstract

03055 **Richter, Dieter.** Bau und Entstehung der Front Range bei Denver in Colorado, U.S.A. als Beispiel eines Uplift in den südlichen Rocky Mountains [Structure and origin of the Front Range near Denver, Colorado, U.S.A. as an example of an uplift in the southern Rocky Mountains: Aufschluss, v. 21, no. 6, p. 201-210, illus., 1970.

The Front Range in Colorado is a mountain chain which resulted from a very strong uplift during which the basement (Precambrian crystalline rocks of the Canadian Shield) was laid bare over a large area. The upward movement took place in several phases after the Paleozoic era. Uplift tectonics is a unique structure type unknown in Europe, and its mechanism may be traced to mass shifting of magma in the Earth's crust. — *from* Author's German abstract, EH

Ridler, R. H. *See* Suffel, G. G. 03461

Riesen, T. *See* Oeschger, H. 03181

03551 **Riley, G. H.** Isotopic discrepancies in zoned pegmatites, Black Hills, South Dakota: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 713-725, illus., tables, 1970.

Rb-Sr isotopic analyses on 10 total-rock samples from the Harney granite yield a total-rock isochron age of 1744 ± 12 m.y. and an initial Sr-87/Sr-86 ratio of 0.7143 ± 0.0006. Four muscovite fractions from the granite give younger ages, and their age deficit can be correlated with Rb concentration. Rb-Sr analyses on 25 mineral specimens from three associated zoned pegmatites yield discordant ages. Ages slightly younger than the granite are observed in all micas, microcline, and pollucite; albite and phosphate mineral assemblages, highly enriched in excess Sr-87, give absurd ages. Spodumene yields ages both higher and lower than the granite. A model which can result in discordant mineral ages and enrichment of Sr-87 in residual fluids is discussed in terms of slow cooling of zoned pegmatites. — *from* Author's abstract

03552 **Riley, G. H.** Excess Sr-87 in pegmatitic phosphates: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 727-731, illus., table, 1970.

Rubidium and strontium concentrations in fifty phosphate samples from complex lithian-rich pegmatites range from 7.5 ppb to 254 ppm and 3.2 ppm to 4320 ppm respectively. The Rb/Sr ratio varies from 4×10^{-4} to 3.4. All pegmatites studied contain phosphates with substantial enrichments of Sr-87. — Author's abstract

03387 **Rimsaite, J.** Structural formulae of oxidized and hydroxyl-deficient micas and decomposition of the hydroxyl group: Contr. Mineralogy and Petrology, v. 25, no. 3, p. 225-240, illus., tables, 1970.

The anionic framework of most natural micas differs from that of ideal mica in the quantity and/or charge of the anions per unit cell. Seven micas were chosen for heating experiments. The structural formulae of the altered micas were calculated on "44+z" valences where "z" is a charge difference between original and altered micas. By comparing the formulae and anionic compositions of dehydrated and altered micas with those of ideal mica, it is possible to study the process of decomposition of the hydroxyl group during oxidation and dehydration. Decomposition depends upon the amount of ferrous iron in the mica, on the composition of the hydroxyl group, and on available atmospheric oxygen, or environmental conditions. Micas containing partly deficient anionic frameworks are susceptible to adsorption of water and argon from the atmosphere. — *from* Author's abstract

Roberson, Charles E. *See* Schoen, Robert. 03167

Roberts, J. L. *See* Hales, A. L. 03513

03620 **Roberts, Michael C.; Klingeman, Peter C.** Drainage density in drift-covered basins — Discussion [of paper 7033 by John F. Orsborn, 1970]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 7, p. 1656-1657, 1970.

Paper 7033 was published *in* ibid., v. 96, no. HY 1, p. 182-192, 1970; *see* Abs. North American Geology, Nov. 1970. The measurement of the drainage net, and need to move from map-based to field-based research are questioned. — GDC

03193 **Roberts, Miriam** (compiler). Bibliography of the geology and mineral resources of Oregon — 4th supplement, January 1, 1956 to December 31, 1960: Oregon Dept. Geology and Mineral Industries Bull. 67, 88 p., 1970.

03601 **Rodolfo, Kelvin S.** Annual suspended sediment supplied to the California continental borderland by the southern California watershed: Jour. Sed. Petrology, v. 40, no. 2, p. 666-671, illus., 1970.

Prominent southern California streams were sampled at their mouths during a rainy season to determine the concentrations, grain sizes, mineralogy, and quantities of suspended sediment supplied to the ocean by the southern California watershed. Approximately 3.5 million tons of suspended sediment are brought to the ocean annually by southern California streams. Some 0.8 million tons are arkosic sands, and the remaining 2.7 million tons of river-supplied sediment are silts, clays, colloids, and dissolved material. The total annual supply of sand to the California coast has been previously estimated at 5 million tons. Approximately 4.2 million tons of sand can be attributed to stream traction load. It is concluded that southern California supplies 7.7 million tons of terrigenous material to the continental borderland every year. — *from* Author's abstract

Rodrique, L. *See* Fuls, P. F. 03122

03299 **Roedder, Edwin.** Application of an improved crushing microscope stage to studies of the gases in fluid inclusions: Schweizer. Mineralog. u. Petrog. Mitt., v. 50, no. 1, p. 41-58, illus., 1970.

This technique (crushing a sample in oil between two plates) has been applied in a variety of inclusion studies. It permits recognition of the presence of as little as 10^{-14} grams of noncondensable gases. In this low range its use has placed some exceedingly low limits on the maximum rate of leakage of certain fluid inclusions, based on the absence of noncondensable gases, and also on the maximum rate of diffusion of air through obsidian glass at surface temperatures. When the embedding oil is replaced with appropriate solvents for expected gases, the technique permits some qualitative analysis of the gases evolved and recognition of some mixtures. Its greatest usefulness lies in providing estimates of gas pressure at room temperature, and in the ease with which useful data may be obtained on the many samples that are too small for analysis by other methods. — *from* Author's abstract

Rogers, Albert M. *See* Gordon, David W. 03309

03658 **Rosauer, Elmer A.** Closed-circuit television in electron microscopy: Iowa Acad. Sci. Proc. 1969, v. 76, p. 350-355, illus., 1970.

Closed-circuit television adapts well to the educational aspects of electron microscopy in terms of extending immediate student participation. The advantages and some examples of the dual role in education and research of such a system are presented. — Author's abstract

Rosenberg, P. E. *See* Hooper, P. R. 03409

03643 **Ross, Charles A.; Nassichuk, Walter W.** *Yabeina* and *Waagenoceras* from the Atlin Horst area, northwestern British Columbia: Jour. Paleontology, v. 44, no. 4, p. 779-781, illus., 1970.

The fusulinaceans *Yabeina* and *Schwagerina* occur with the cephalopods *Waagenoceras*, *Stacheoceras*, *Agathiceras*, and *Hyattoceras* in the [Permian] Cache Creek Group in northwestern British Columbia. The species of *Yabeina* have affinities with *Y. ozawai* from the lower part of the *Neoschwagerina margaritae* Zone in Japan, and the cephalopods have affinities with those from the Wordian Stage of

southwestern North America. This occurrence supports a correlation of the upper part of the *Neoschwagerina* Zone of the Tethyan faunal province with the upper part of the Zone of *Parafusulina* in the Midcontinent-South American faunal province. — Author's abstract

03278 **Ross, John V.** Structural evolution of the Kootenay Arc, southeastern British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 53-65, illus., geol. map, 1970.

The Kootenay Arc in southeastern British Columbia comprises rocks ranging in age from late Proterozoic to Triassic. These rocks have undergone polyphase deformation, the first and main phase characterized by the development of large-scale recumbent folds overturned to the east and in part thrust over and against the Purcell anticlinorium. The major Phase 1 folds culminate and depress along strike. Phase 2 is deformed along southeasterly-trending axial surfaces that dip southwestward. Phase 3, deformed along southerly-trending axial surfaces that dip eastward, warped the 2 previous sets of fold directions. Progressive metamorphism accompanied Phase 1 and 2 deformation, reaching a maximum during the latter. Retrogressive metamorphism accompanied Phase 3 deformation. The geometry of the arc is the result of easterly crowding of Phase 1 recumbent structures against the Purcell basement and must be of pre-Mesozoic age. — *from* Author's abstract

03545 **Ross, June R. P.** Discussion of "On the validity of the name *Hallopora* for a genus of trepostome bryozoan," by R. J. Singh [1970]: Jour. Paleontology, v. 44, no. 4, p. 785, 1970.

Singh's nomenclatural note (ibid., v. 44, no. 4, p. 784-785, 1970) is abstracted in this issue of Abstracts of North American Geology.

Ross, Malcolm. *See* Prewitt, C. T. 03367

03286 **Royse, Chester F., Jr.** A sedimentologic analysis of the Tongue River-Sentinel Butte interval (Paleocene) of the Williston Basin, western North Dakota: Sed. Geology, v. 4, no. 1, p. 19-80, illus., tables, 1970.

Distinctive stratigraphic relations at this contact earn for Sentinal Butte deposits formational rank. Granulometric analyses of 500 samples from nine stratigraphic sections amplify textural differences between the two exogeosynclinal units. Tongue River sediments are finer, less well sorted; C-M patterns differentiate fluvial backswamp, floodplain, and channel facies. From primary sedimentary structures, composition, and stratigraphic abundance, interpretation is made in two sedimentation models. Tongue River dispersal was eastward by slow streams from a low-lying source area, rate of sedimentation was controlled by uniform basin subsidence. With influx of coarse sediments, Sentinel Butte dispersal was eastward to southeastward across late Tongue River swamps, by slightly faster streams; variable paleoslope reflects tectonism to west and northwest in elevating western North Dakota. — *from* Author's summary

03102 **Ruiz, Patricio.** Probabilistic study of the behavior of structures during earthquakes [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4645B-4646B, 1970.

03394 **Rupke, N. A.** Continental drift before 1900: Nature, v. 227, no. 5256, p. 349-350, 1970.

The idea that Francis Bacon and other seventeenth and eighteenth century thinkers first conceived the notion on continental drift does not stand up to close scrutiny. The few authors who expressed the idea viewed the process as a catastrophic event. — Author's abstract

Rushforth, Samuel R. *See* Tidwell, William D. 03452

03016 **Rushforth, Samuel Roberts.** Notes on the fern family Matoniaceae from the western United States: Brigham Young Univ. Geology Studies, v. 16, pt. 3, p. 3-34, illus., tables, 1969 [1970].

A Cretaceous fern flora has been recently discovered near Westwater, Grand County, Utah. Among specimens collected from Westwater are forms related to extant members of the fern family Matoniaceae. This family was widely distributed geographically throughout most of the Mesozoic, and matoniaceous ferns have been collected from several fossil localities in the United States. The Matoniaceae was especially important in the United States during Lower Cretaceous times. Five species, *Matonidium brownii* Rushforth, *M.*(?) *lancipinnulum* Rushforth, *M. galleyi* (Miner) Rushforth, *M. americanum* Berry em. Rushforth. and *M.*(?) sp., and one variety, *M. brownii* var. *magnipinnulum* Rushforth, are considered in the present paper. — *from* Author's abstract

03572 **Rushton, K. R.; Bannister, R. G.** Aquifer simulation on slow time resistance-capacitance networks: Ground Water, v. 8, no. 4, p. 15-24, illus., table, 1970.

For several years resistance-capacitance networks have been used to simulate aquifers. Most reported work has been concerned with fast time analogs in which the period under consideration is represented in micro-seconds. However, the alternative slow time analog has many advantages since the electrical experiment takes several seconds. This results in simpler equipment and simpler experimental techniques. The paper concentrates on the practical aspects of the slow time analog giving details of the components, describing a method of simulating wells and recharge and comparing measuring instruments. The techniques are illustrated by a simplified example. — Authors' abstract

03229 **Russell, Eugene R.; Mickle, Jack L.** Liquid limit values by soil moisture tension: Am. Soc. Civil Engineers Proc., v. 96, paper 7298, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 967-989, illus., tables, 1970.

The feasibility of using soil moisture tension to determine consistency limit values is investigated. Samples, mostly clays, silty clays, and silty clay loams, with known limits determined by standard methods were obtained from the Iowa State Highway Commission. A total of 687 liquid limits and 273 plastic limits are determined using varying moisture tensions on pressure plate and pressure membrane apparatus respectively. The effect of textural groups on liquid limit determination is not especially critical; moisture tensions vary between 40 and 70 inches of water pressure. A definite relationship between consistency limits and moisture tension curves is theoretically proved. The moisture tension method can produce a liquid limit value essentially the same as would be obtained by the standard ASTM method, but with better reproducibility, and essentially no operator variability. In general, plastic limit results are not acceptable, except perhaps for clays. — *from* ASCE abstract

Russell, R. D. *See* Ozard, J. M. 03361

03049 **Sabina, Ann P.** Rocks and minerals for the collector — Hull-Maniwaki, Quebec; Ottawa-Peterborough, Ontario: Canada Geol. Survey Paper 69-50, 177 p., illus., 1970.

Occurrences of minerals, rocks and fossils are described from about 200 easily accessible localities in the Gatineau River area, Quebec, and along Highway 7 from Ottawa to Peterborough, Ontario. In the Gatineau district, good specimens are available from numerous abandoned mica-apatite mine dumps; other nonactive mines have deposits of iron, brucite, molybdenum, feldspar, barite, zinc, asbestos, quartz, and limestone. The Leduc mine has been exploited for tourmaline; fossils occur only in the Hull area. In the Ontario section, nepheline, cancrinite, marble, serpentine, epidote, peristerite and graphic granite are examples of lapidary material. Ordovician fossils are abundant in road cuts and in limestone quarries near Peterborough. — *from* Author's abstract

03563 **Sackett, William M.; Rankin, John G.** Paleotemperatures for the Gulf of Mexico: Jour. Geophys. Research, v. 75, no. 24, p. 4557-4560, illus., 1970.

The δO-18 range in *Globigerinoides rubra* in a Sigsbee knoll core indicates a temperature range of about 5°C for the Gulf of Mexico during the Pleistocene age. By use of the empirically determined temperature dependence of δC-13 of photosynthetically fixed carbon and by use of observed values for various sediment cores, a temperature range up to 35°C is suggested. A greater contribution of terrestrially derived light organic carbon during the cold relative to the warm periods may explain the anomalous carbon-isotope-derived paleotemperature range for the Gulf of Mexico. — Authors' abstract

03068 **Sahl, Howard Leroy.** Mobeetie Field, Wheeler County, Texas: Shale Shaker, v. 20, no. 6, p. 108-115, illus., 1970.

This field on the southwest edge of the Anadarko Basin has 31 wells producing oil and gas chiefly from Pennsylvanian granite washes. The Pennsylvanian-Permian section reflects a declining uplift of the Amarillo Mountains; the Mobeetie anticline lies on a parallel regional horst, with a southeastward plunge 5,000 feet high on the Ellenburger level at the basal Pennsylvanian unconformity. Markedly sharper structure there is due to a pre-unconformity cross fault. In composition the granite wash is about one-half unaltered granite and quartz, and one-third feldspar; secondary chlorite, containing chemically bound water, is significant for its effect on the water saturation value. Above the Ellenburger, the Simpson sand and Viola dolomite produce too little to be of commercial value. Ultimate recovery from all Mobeetie zones is estimated at about 5,000,000 bbl oil and 60 bcf gas. — GDC

03334 **Sainsbury, C. L.; Hudson, Travis; Kachadoorian, Reuben; Richards, Thomas.** Geology, mineral deposits, and geochemical and radiometric anomalies, Serpentine Hot Springs area, Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 1312-H, p. H1-H19, illus., tables, geol. map, 1970.

Placer cassiterite and gold on Humboldt Creek, Seward Peninsula, Alaska, is probably derived from quartz veins and altered rocks along a complex system of high-angle and thrust faults near the granite of Serpentine Hot Springs. Geochemical exploration in conjunction with geologic mapping has outlined several targets, one of which contains outcropping argentiferous galena. Stream-sediment surveys were ineffectual in locating the mineralized structures, whereas panned stream concentrates successfully indicated the existence of the mineralized lodes found subsequently. — CLS

03737 **Saint Amant, M.; Strangway, David W.** Dielectric properties of dry, geologic materials: Geophysics, v. 35, no. 4, p. 624-645, illus., table, 1970.

A detailed investigation of dielectric properties of powdered and solid dry rocks in the frequency range 50 kg to 2 mhz has revealed that: (1) All show an increase in dielectric constant and loss tangent as frequency decreases and temperature increases; this dispersion is believed due to polarization associated with charge buildup at grain boundaries or at grain imperfections. (2) Dry powdered rocks often show a thermally-activated relaxation peak with a typical Debye-relaxation character; this is due to presence of pyroxene and biotite and may be associated with other minerals. In solid rocks the relaxation peak is hidden in the low-frequency dispersion. (3) At high frequencies the loss tangent approaches a constant value which is frequency independent; this is observed in many dielectrics and may be the result of a distribution of relaxation times. — *from* Authors' abstract

03592 **Saint John, Brian E.** Ultra-trace element analysis of carbonate rocks by APDC-MIBK extraction and atomic absorption spectrophotometry: Jour. Sed. Petrology, v. 40, no. 2, p. 537-541, tables, 1970.

Microanalysis of carbonate rocks using APDC-MIBK extraction and atomic absorption can be accomplished through the use of a sodium hydroxide-ammonium chloride buffer. The sensitivity of the method is in the part-per-billion range and the potential extension of the method to allow the simultaneous extraction of up to 20 elements is indicated. Analysis of three samples of *Millepora sp.* from the Coral Sea for Co, Cd, Cu, Ni, Zn, Fe, and Pb are presented. The APDC-MIBK extraction system can be used for ultra-trace element analysis of fresh water, sea water, sedi-

ment interstitial water, briny ground water, granite, and carbonate sediment and rock. — Author's abstract

Salisch, H. A. *See* Raymer, L. L. 03521

03561 **Sammis, Charles; Anderson, Don; Jordan, Tom.** Application of isotropic finite strain theory to ultrasonic and seismological data: Jour. Geophys. Research, v. 75, no. 23, p. 4478-4480, table, 1970.

The finite strain expressions, originally derived by F. Birch (1938), for the compressional and shear velocities in an isotropic solid under hydrostatic pressure, when rederived to be complete to first order in the strain, are functions of both the second- and third-order elastic constants. The extra terms appearing in the complete first-order theory for the velocities and their pressure derivatives are of the order of the ordinary elastic constants. There is no longer any discrepancy between first-order finite strain theory and ultrasonic and seismic data. — Authors' abstract

Sandberg, G. W. *See* Sumsion, C. T. 03063

03543 **Sanderson, G. A.** A bibliography of the family Fusulinidae, addendum 7: Jour. Paleontology, v. 44, no. 4, p. 770-775, 1970.

Addendum 7 comprises 185 references dealing with fusulinacean Foraminifera. The cumulative total in this series now stands at 2200. — *from* Author's introduction

03099 **Sanderson, Robert Michael.** Prediction equations for building vibrations [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4611B, 1970.

03224 **Sangrey, Dwight A.; Shanker, N. Babu.** Property interrelationships in sensitive clays — Discussion [of paper 6666 by W. N. Houston and J. K. Mitchell, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 1067-1071, illus., table, 1970.

Paper 6666 (ibid., v. 95, no. SM4, p. 1037-1062, 1969) was cited in Abstracts of North American Geology, April 1970.

03454 **Sangster, A. L.; McCartney, W. D.** Metallogeny of the Grenville province of southeastern Ontario [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 283, 1970.

03647 **Sass, J. H.; Munroe, Robert J.** Heat flow from deep boreholes in two island arcs: Jour. Geophys. Research, v. 75, no. 23, p. 4387-4395, illus., tables, 1970.

Heat flow was determined for deep boreholes at four sites on Amchitka Island, Alaska, and at one site near the northern central coast of Mindanao Island, Philippines. Temperatures at all Amchitka sites were affected by vertical water movement, but portions of all temperature profiles were suitable for heat-flow determinations. Measured heat flow increases with depth; if allowance is made for a post-glacial increase in mean surface temperatures, an equilibrium heat flow of 1.3μ cal per sq cm per sec results. At Mindanao two independent determinations over intervals of contrasting thermal conductivity agree, with a mean value of 1.1. Measurements of near-surface radioactivity from both areas suggest that only a small fraction of observed heat flux can be attributed to radioactive heat production in the crust. — *from* Authors' abstract

03121 **Sawhney, B. L.** Potassium and cesium ion selectivity in relation to clay mineral structure [with French, German and Russian abs.]: Clays and Clay Minerals, v. 18, no. 1, p. 47-52, illus., tables, 1970.

Selectivity of a number of vermiculites, montmorillonites, and micas for K and Cs ions was determined by sorption from equilibrium solutions of diverse concentrations. Selectivity coefficients were related to layer charge density and the area of frayed edges in layer silicates. Montmorillonites had the smallest selectivity for both

ions, while biotite and illite had the greatest, but limited to small concentrations of K. At greater concentrations, selectivity of vermiculite for K exceeded that of the micas. The greater selectivity of vermiculites over montmorillonites for K and Cs ions was attributed to their greater layer charge density. The greater selectivity of micas was attributed to the frayed edges in addition to their larger layer charge density. As the area of frayed edges in illite increased by removal of interlayer K, the selectivity of illite for K also increased, confirming the selectivity of frayed edges for K. — *from* Author's abstract

03724 **Saxena, Surendra Kumar.** A statistical approach to the study of phase equilibria in multicomponent systems: Lithos, v. 3, no. 1, p. 25-36, illus., tables, 1970.

Eigenvalues and eigenvectors obtained from correlation coefficient matrix of a multicomponent multiphase system are used for the diagrammatic representation of the system. On such representations, it is possible to plot certain relative positons of all coexisting minerals as well as of the components. Tie lines joining points representing a pair of coexisting minerals in such figures are significant in the same way as they are in the concentration diagrams (Gibbs triangle for instance), but with the added advantage that they now represent the influence of all the components in the system. Diagrammatic representation of phase equilibria in charnockites from Varberg, Madras, Uusimaa, and in certain metamorphosed iron formations from Quebec is made by using this statistical approach. — Author's abstract

03437 **Sayre, William W.** Dispersion of silt particles in open channel flow — Closure [to discussion of paper 6579, 1969, with errata]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 8, p. 1722-1723, 1970.

For Paper 6579 *see* ibid., v. 95, no. HY 3, p. 1009-1038, 1969; Abs. of North American Geology, Feb. 1970.

03484 **Schau, M. P.** RB/SR, S, and O isotopic analyses indicating source and date of contact metasomatic copper deposits, Craigmont, British Columbia, Canada — Discussion [of paper by L. Chrismas and others, 1969]: Econ. Geology, v. 65, no. 1, p. 62-63, table, 1970.

For original paper, *see* ibid., v. 64, no. 5, p. 479-488, 1969; Abs. North American Geology, April 1970.

03281 **Schau, Mikkel.** Stratigraphy and structure of the type area of the Upper Triassic Nicola Group in south-central British Columbia, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 123-135, illus., table, 1970.

The Upper Triassic Nicola group represents broken remnants of a volcanic archipelago; about 23,000 feet of sediments and volcanic rocks are present. The group is the product of two cycles of deposition distinguishable on the basis of relative abundance of phenocrysts in the volcanic members. In Early Jurassic times the group was gently folded, fractured, and intruded by a sequence of plutons culminating in the near-surface emplacement of huge batholiths. Metamorphism and metasomatism altered the rocks to the present low-grade metamorphic mineral assemblages. By mid-Mesozoic time plutons were exposed and a conglomerate laid down. Faulting occurred during late Mesozoic time. Eocene deposits were laid down in an environment of hills and swamps. By late Miocene the main topographic features of the Interior Plateau were fixed, and were little affected by Plateau and Valley basalts, glacial erosion and deposits. — *from* Author's abstract

03424 **Scheidegger, A. E.** Comment on 'Comparison of Smart and Scheidegger stream length models' by J. S. Smart [1969]: Water Resources Research, v. 6, no. 3, p. 996-997, 1970.

This is a reply to J. S. Smart's discussion (ibid., v. 5, no. 6, p. 1383-1387, 1969) of Scheidegger's paper, "Horton's law of stream lengths and drainage areas" (ibid., v. 4, no. 5, p. 1015-1021, 1968; Abs. North Am. Geology, April 1969). — ESL

03291 **Scherer, G.; Vergano, P. J.; Uhlmann, D. R.** A study of quartz melting: Physics and Chemistry Glasses, v. 11, no. 3, p. 53-58, illus., tables, 1970.

The kinetics of melting of quartz have been measured at temperatures of 1500°, 1600°, and 1650°C. Recent thermochemical data have been used to estimate a melting point (1700°K) and a heat of fusion (220 cal/mole) for quartz and (2400 cal/mole) for cristobalite. With these values, the viscosity data of Hofmaier and Urbain, and the melting rate data of the present and previous studies, the reduced melting rate was evaluated and found to be independent of superheat. Within experimental error, magnitude of the reduced melting rate for quartz is the same as the reduced melting and crystallization rates for cristobalite. No evidence is found for direct transformation from quartz to cristobalite; and arguments are advanced that some previous reports of a direct quartz-cristobalite transformation are observations of metastable melting of quartz followed by crystallization of the melt: — *from* Authors' abstract

03675 **Schiffman, Robert L.** The stress components of a porous medium: Jour. Geophys. Research, v. 75, no. 20, p. 4035-4038, 1970.

The state of stress in a porous medium is defined. The nature of the stress-strain relationship for each component is analyzed. The assumptions necessary to achieve symmetry of the partial stresses are discussed. The role of the soil-water interaction coefficient is developed. We show that this coefficient is the coupling term relating soil-skeleton and pore-fluid deformations. — Author's abstract

03379 **Schmidt, Dwight L.; Mackin, J. Hoover.** Quaternary geology of Long and Bear Valleys, west-central Idaho: U.S. Geol. Survey Bull. 1311-A, p. A1-A22, illus., geol. maps, 1970.

Monazite and euxenite were extensively dredged in Long and Bear Valleys during 1951-59. These and other accessory heavy minerals were released from the rocks of the Idaho batholith by deep weathering during the Tertiary and early Quaternary. Concentration of the heavy minerals in large Quaternary placers depended on particular sets of circumstances, variously involving block faulting and glacial and periglacial processes. Miocene Columbia River Basalt is commonly tilted 15°-30° W. and early or middle Pleistocene lacustrine deposits are tilted 20° as a result of block faulting. Bull Lake and Pinedale glacial deposits are most widespread and a few outcrops of ancient till may represent an extensive pre-Bull Lake drift. Pinedale and Bull Lake periglacial deposits are prevalent in small nonglaciated drainage basins. — DLS

Schmidt-Bleek, F. *See* Laul, J. C. 03651

Schneider, E. D. *See* Vogt, P. R. 03670

03167 **Schoen, Robert; Roberson, Charles E.** Structures of aluminum hydroxide and geochemical implications: Am. Mineralogist, v. 55, nos. 1-2, p. 43-77, illus., tables, 1970.

Synthesis experiments in the alumina-water system at room temperature indicate that the gibbsite polymorph precipitates slowly from solutions whose pH is below the point of minimum solubility (pH 5.8), and the bayerite polymorph precipitates rapidly when pH is above 5.8. Nordstrandite, the third polymorph of aluminum hydroxide, forms from bayerite during aging at intermediate to high pH values. In solutions of intermediate pH, both gibbsite and bayerite form; with aging, however, early-formed gibbsite disappears as more bayerite forms. The principal structural difference among the three aluminum hydroxide polymorphs is in the mode of stacking successive layers. The usual abundance of the silicate ion in natural alkaline environments may explain the scarcity of nordstrandite, because the silicate ion may favor the precipitation of alumino-silicate minerals rather than aluminum hydroxide. — *from* Authors' abstract

03531 **Scholl, David W.; Buffington, Edwin C.; Hopkins, David M.; Alpha, Tau Rho.** The structure and origin of the large submarine canyons of the Bering Sea: Marine Geology, v. 8, nos. 3-4, p. 187-210, illus., 1970.

Bering Canyon, the world's longest known slope valley, is 400 km long, and has a volume of 4,300 km³. The volume of Pribilof Canyon is 1,300 km³, and that of Zhemchug is 8,500 km³ and is probably the world's largest slope valley. Pribilof and Zhemchug are bifurcated headward to form basins behind the regionally projected position of the shelf edge. The data and conclusions in this work stress that the location, trend, and shape of these canyons are structurally determined. Bering Canyon was periodically cut and filled by axial sedimentation during Tertiary and Quaternary time, whereas Pribilof and Zhemchug are entirely Pleistocene. During intervals of glacially lowered sea level, the Kuskokwim and Yukon rivers emptied into or near the heads of Pribilof and Zhemchug. The enormous size and the shape of Zhemchug resulted from breaching and excavation of a Tertiary-rock-filled basin. — HRC

03559 **Scholz, C. H.; Fitch, Thomas J.** Strain and creep in central California: Jour. Geophys. Research, v. 75, no. 23, p. 4447-4453, illus., tables, 1970.

Long geodimeter lines across the San Andreas, Hayward, and Calaveras faults were compared with measured creep rates of these faults. Creep accounted for only about one third of the long line changes. The residual line changes indicate an accumulating strain field having a principal compressive strain rate of -0.50×10^{-6} at N11° E and a tensile strain rate of 0.50×10^{-6} per yr, or shear at a rate of 0.50×10^{-6} per yr. This is 25 percent less than if creep had not occurred, supporting the conclusion that creep on these faults does not significantly release accumulating strain. The possibility that creep on other, secondary, faults in the area can explain the geodimeter data is explored. An ad hoc model is obtained, with creep on Silver Creek, Calaveras, Sargent, and Paicines faults of 1.0, 0.6, 2.0, and 2.0 cm per yr, respectively. Measurements across all these faults might answer the question of seismic risk in central California. — *from* Authors' abstract

Schopf, J. William. *See* Smith, J. W. 03638

03345 **Schopf, Thomas J. M.; Allan, J. R.** Phylum Ectoprocta, Order Cheilostomata — Microprobe analysis of calcium, magnesium, strontium, and phosphorus in skeletons: Science, v. 169, no. 3942, p. 280-282, illus., 1970.

The phylum Ectoprocta (Bryozoa in part) includes 20,000 living and extinct species and ranks as one of the more diverse groups of organisms. Calcium, magnesium, and strontium occur in approximately constant ratios in traverses through skeletal walls of a single mineralogy (either calcite or aragonite). Skeletal walls of more than one mineralogy have the magnesium-rich layer (calcite) surrounding the living chamber and the strontium-rich layer (aragonite) on the outside. In contrast, phosphorus may be present in greater or lesser amounts in different parts of the same skeletal wall. Aragonitic crystallites appear oriented roughly perpendicular to skeletal walls, whereas calcitic crystallites are parallel to skeletal walls. — DBV

03415 **Schram, Frederick R.** Isopod from the Pennsylvanian of Illinois: Science, v. 169, no. 3948, p. 854-855, illus., 1970.

Hesslerella shermani is described as the oldest representative of the crustacean superorder Peracarida, order Isopoda, suborder Phreatoicidea. This description is based on a single specimen of exceptional preservation from the Middle Pennsylvanian of Illinois. The existence of isopods in the Pennsylvanian raises some questions concerning peracarid and eumalocostracan evolution. — Author's abstract

03602 **Schroeder, Johannes H.; Miller, Donald S.; Friedman, Gerald M.** Uranium distribution in Recent skeletal carbonates: Jour. Sed. Petrology, v. 40, no. 2, p. 672-681, illus., tables, 1970.

In corals, fission-track analysis showed a zone next to the internal surface of the corallite where uranium is enriched with respect to the inner portions of the skeleton; it is variable between species. *Oculina diffusa* shows alternating bands of relatively high and low U contents subparallel to the external surface. In mollusks, U varied between layers in the same shell, and within a layer perpendicular to the accretion direction. All the variations result from variations in skeleton growth and formation. Random distribution occurs in all types also. Trace-element distribution in carbonate

skeletons is determined primarily by biologic processes and can be expected to change when affected by physico-chemical diagenetic influences. — HRC

03420 **Schubert, Gerald; Turcotte, D. L.; Oxburgh, E. R.** Phase change instability in the mantle: Science, v. 169, no. 3950, p. 1075-1077, illus., 1970.

In the presence of a temperature gradient, phase changes of the type believed to exist in the upper mantle, in which the less dense phase lies above the dense phase, may be unstable. Approximate calculations show such phase change instabilities are possible for both the 400-kilometer olivine-spinel phase transition and also for partial melting at shallower depths. The resulting flow patterns may provide a driving mechanism for the new global tectonics. — Authors' abstract

03436 **Schumm, Stanley A.** River metamorphosis — Closure [to discussion of paper 6352, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 8, p. 1715-1716, 1970.

For Paper 6352 *see* ibid., v. 95, no. HY 1, p. 255-273, 1969; Abs. of North American Geology, June 1969.

03111 **Schwartz, Maurice Leo.** Beach profile translation; scale of shore erosion [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4664B-4665B, 1970.

03610 **Scoffin, Terence P.** A conglomeratic beachrock in Bimini, Bahamas: Jour. Sed. Petrology, v. 40, no. 2, p. 756-759, illus., 1970.

In the intertidal zone on the west coast of North Bimini clasts of *Strombus* shells, coral skeletons, glass bottles, and carbonate sand have been wedged by wave action between boulders of limestone derived from a nearby cliff. These clasts are being rapidly cemented by acicular aragonite to form a conglomeratic beachrock. — Author's abstract

03432 **Scolaro, Reginald J.** Notes on Miocene Bryozoa from northwestern Florida: Tulane Studies Geology and Paleontology, v. 8, no. 2, p. 93-98, illus., 1970.

Three species of cheilostome Bryozoa from two Miocene formations in northwestern Florida are described herein. *Discoporella umbellata depressa* (Conrad) and *Hippoporidra calcarea* (Smitt) are reported for the first time from the Red Bay Formation. The occurrence of *D. umbellata depressa* and *Cupuladria biporosa* Canu and Bassler represent the first report of Bryozoa from the Yellow River Formation. As these species are broad ecologic indicators, it is thought that the Red Bay and Yellow River formations were deposited in muddy, somewhat turbulent, warm temperate environments and under conditions adverse to the development of a large bryozoan community. — Author's abstract

Scott, James H. *See* Yacoub, Nazieh K. 03698

03046 **Seed, H. Bolton.** Soil problems and soil behavior, Chap. 10 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 227-251, illus., 1970.

It is possible at the present time to delineate reasonably well the soil stability problems that occur during earthquakes and to illustrate them by means of examples from recent and older earthquakes. The similarity of types of soil instability problems encountered in such widely separated locations as Alaska, Niigata (Japan), and Chile are discussed and summarized in a table. — VSN

03355 **Seed, H. Bolton; Idriss, I. M.** Analyses of ground motions at Union Bay, Seattle during earthquakes and distant nuclear blasts: Seismol. Soc. America Bull., v. 60, no. 1, p. 125-136, illus., tables, 1970.

Recordings of accelerations at three different depths within the soil profile at Union Bay were obtained during a mild nearby earthquake and three distant nuclear blast

events. These recordings were made by instruments placed in peat 10 feet, in clay 61 feet, and in glacial till 105 feet below the ground surface. Accelerations in the EW, NS and vertical directions were recorded simultaneously at these depths. Using an equivalent linear variable damping lumped-mass solution, incorporating strain-dependent material properties for peat and clay layers, motions throughout the deposits were computed. Recorded accelerations in the glacial till were used as input base motion. Comparisons of motions recorded during the nearby earthquake with the corresponding computed motions and nuclear blast motions indicated a high degree of agreement. —*from* Authors' abstract

03448 **Seed, H. Bolton.** Earth slope stability during earthquakes, Chap. 15 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 383-401, illus., table, reprinted 1970; originally published 1967.

The pseudostatic method of analysis of embankment stability against earthquake forces used in the past involves computation of a minimum factor of safety against sliding when a static, horizontal force of some magnitude is present; the horizontal force is expressed as a product of a seismic coefficient and the weight of the potential sliding mass, and when the factor of safety approaches unity, the section is considered unsafe. This method has little value in guiding the design engineer in selecting an appropriate value for the seismic coefficient and is inadequate to explain mechanics of many failures. Significant recent progress made in development of new concepts in earthquake-resistant design of embankments, new and improved methods of response analysis, new methods of soil testing to determine properties controlling soil behavior during earthquakes, and new interest in documentation and analysis of actual failure is discussed. — VSN

03635 **Seed, H. Bolton; Idriss, I. M.; Kiefer, Fred W.** Characteristics of rock motions during earthquakes — Closure [to discussion of paper 6783, 1969]: Am. Soc. Civil Engineers Proc., v. 96, paper 7385, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1468-1469, illus., 1970.

Paper 6783 was published *in* ibid., v. 95, no. SM 5, p. 1199-1218, 1969; *see* Abs. North American Geology, April 1970.

Senko, E. E. *See* Styra, B. I. 03221

Shanker, N. Babu. *See* Sangrey, Dwight A. 03224

03605 **Sharma, G. D.** Evolution of interstitial waters in Recent Alaskan marine sediments: Jour. Sed. Petrology, v. 40, no. 2, p. 722-733, illus., tables, 1970.

Sodium ion concentration in the interstitial waters [of glacio-marine sediments from southeastern Alaska] was found to vary with depth and between cores. Removal of Na and enrichment of Ca in sea water occurs during early stages of sediment-sea water interaction. Removal of Mg accompanied by further removal of Na from sea water results from thorough mixing of sediments and sea water during transport. The changes in the interstitial waters observed are primarily due to ion exchange between sediments and trapped pore waters. Sediments containing larger silt fractions seem to remove less Na from trapped waters than those containing less silt. Particle size distribution, especially within the clay-sized range, mineralogy, and exposure time of sediments appear to control the nature and content of ion exchange between sediments and sea water. —*from* Author's abstract

Shen, C. K. *See* Lee, Kenneth L. 03633

Shido, Fumiko. *See* Miyashiro, Akiho. 03714

03755 **Shiftan, Z. L.** Integration of geophysics and hydrogeology in the solution of regional groundwater problems [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 507-512; discussion, p. 512-516, illus., 1970.

The present worldwide increase in demand for ground water is responsible for the growing number of ground-water exploration and development projects of regional size, requiring accuracy in evaluation of available resources; an integrated application of geological, geophysical, and hydrological methods and test drilling is needed. In such projects, geophysics will be employed mainly in coordination with geological studies and drilling to establish a model of subsurface structure of the region and existing aquifers, and will serve as an instrument for solution of a variety of special hydrological problems. Further standardization of geophysical field procedure, instrumentation, interpretation, and presentation of results for methods most frequently applied in ground-water investigation could make an important contribution to future large-scale use of geophysics in these projects. — *from* Author's abstract

03354 **Shopland, Robert C.; Kirklin, Richard H.** Application of a vertical strain seismograph to the enhancement of P waves: Seismol. Soc. America Bull., v. 60, no. 1, p. 105-124, illus., 1970.

Enhancement of P waves is obtained by the suppression of microseisms with a combination of vertical linear strain seismograph and vertical inertial seismograph outputs. Significant suppression is observed at sites where the predominant microseisms consist of essentially single-mode Rayleigh waves in contrast to that observed at a site where the microseismic noise is compositionally more complex. A description is given of the vertical linear strain seismograph used in these investigations. Consideration is given to the use of a vertical transverse strain seismograph at sites where the microseismic noise field is complex. — Author's abstract

03182 **Shotton, F. W.; Blundell, D. J.; Williams, R. E. G.** Birmingham University radiocarbon dates IV: Radiocarbon, v. 12, no. 2, p. 385-399, 1970.

Shugurova, N. A. *See* Sobolev, V. S. 03577

Sides, Geoffrey R. *See* Barden, Laing. 03627

03717 **Silvester, Richard.** Growth of crenulate shaped bays to equilibrium: Am. Soc. Civil Engineers Proc., v. 96, paper 7274, Jour. Waterways and Harbors Div., no. WW 2, p. 275-287, illus., 1970.

The coastal outline between headlands assumes a specific shape which is related to the direction of the most predominant waves in the area. This half-heart or crenulate shape has been recognized previously and used to determine net longshore drift along land margins of the world. The curved section of such bays has been shown to follow a logarithmic curve. The present study indicates that in the development of a bay, from an initial straight coastline between two headlands, the constant in the spiral curve varies. It approaches a specific limiting value which is determined solely by the obliquity of the waves to the headland alignment. Thus scale of operation, either model or prototype, is not influential. By checking the spiral constant and wave approach angle of any bay, a test can be made of its state of equilibrium. A prediction is thus available for the erosion that could occur should upcoast sediment supply be impeded. — ASCE abstract

03740 **Silvester, Richard; delaCruz, Catalino del Rosario.** Pattern forming forces in deltas: Am. Soc. Civil Engineers Proc., v. 96, paper 7260, Jour. Waterways and Harbors Div., no. WW 2, p. 201-217, illus., tables, 1970.

The distinctive accretion pattern in the deltas of the world would appear to be controlled by forces associated with the river system, the receiving mass of water, and the climate of catchment and delta region. An examination of these variables has been carried out by a regression analysis, from which predictive equations indicate their degree of influence. For this purpose separate deltaic features were tested individually and in combination against the independent variables supplying the material and conditions for deposition. The resultant equations were found to confirm many known generalizations regarding delta formation and to highlight a few which have not been stressed in the literature previously. — ASCE abstract

03659 **Simon, D. E.; Elwell, J. H.** Statistical methods for integrating populations of a fauna collected at various localities: Iowa Acad. Sci. Proc. 1969, v. 76, p. 267-274, illus., tables, 1970.

Parameters characteristic of *Atrypa hystrix*, collected from various localities of the Cerro Gordo Member of the Upper Devonian Lime Creek Formation, were measured as: 1) length, 2) width, 3) thickness, 4) number of growth lines, and 5) number of plications. The consistency of data obtained within a sample location was tested against similar data representing the total population by means of F-tests. Results suggested that the three sample locations represented at least two statistically random sample populations. These statistical differences in the single biologic population may be alternately interpreted as: 1) the population differed prior to preservation, or 2) is attributed to post depositional changes at the sample locations. F-tests of the parameter ratios increased resolution sufficiently to suggest a single sample population statistically characteristic of the one biologic population. — Authors' abstract

Simonsen, Stanley H. *See* Cummings, John P. 03169

03018 **Simony, P. S.; Wind, G.** Structure of the Dogtooth Range and adjacent portions of the Rocky Mountain Trench, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 41-51, illus., geol. map, 1970.

In the map area northwest of Golden in the Dogtooth Range of British Columbia, the rocks range in age from Proterozoic to Late Cambrian and consist of slate, grit, quartzite and carbonate rocks belonging to the chlorite zone of metamorphism. The range consists of a series of major folds, having axes plunging south at about 15° and axial planes that dip steeply southwest, cut and telescoped by southwest-dipping thrust and later normal faults. The fold geometry is influenced by the Lower Cambrian Hamill quartzite which acted as the dominant member during folding. Three sets of kink bands affect the area, two forming a conjugate system. From stratigraphic and structural reconstruction, it is estimated that the uppermost Proterozoic rocks, now at 3000 feet elevation, were buried to a depth of at least 30,000 feet with thrust faulting a mechanism of deformation to a depth of at least 40,000 feet. — *from* Author's abstract

03582 **Sims, Paul; Morey, G. B.** A teacher's guide for geologic field investigations in north-central Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, 14 p., illus. [n.d.].

Rocks in the area are dominantly Precambrian with some Cretaceous, both covered by Pleistocene sediments. Layers and lenses of the Soudan Iron-Formation occur in the Ely Greenstone, and contain the important hematite ore bodies. The Knife Lake Group overlies these, and all are cut by pink and gray granites. The Biwabik Iron-Formation on the Mesabi range is younger than these. Excursions are centered around four specific areas: Cook-Tower, Ely, Virginia-Eveleth-Gilbert, and Grand Rapids. — ESL

03544 **Singh, Raman J.** On the validity of the name *Hallopora* for a genus of trepostome bryozoan: Jour. Paleontology, v. 44, no. 4, p. 784-785, 1970.

Calopora Hall 1851 is thought to be a misspelling of *Callopora* Hall 1852 and a junior subjective synonym of *Callopora* Gray 1848. *Hallopora* Bassler 1911 is regarded as the valid name for the lower Paleozoic bryozoan genus, rather than *Calopora*, as suggested by June R. P. Ross (1969). — JWH

Singh, Shri K. *See* Kuo, John T. 03522

03632 **Singh, Sukhmander.** Bonding, effective stresses, and strength of soils — Discussion [of paper 6786 by J. K. Mitchell, Awtar Singh, and R. G. Campanella, 1969]: Am. Soc. Civil Engineers Proc., v. 96, paper 7385, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1469-1470, 1970.

Paper 6786 was published *in* ibid., v. 95, no. SM 5, p. 1219-1246, 1969. *See* Abs. North American Geology, April 1970.

03738 **Škvor, Vladimir.** Reply [to discussion by C. W. Hatten and A. A. Meyerhoff, 1970, of "The Caribbean area, a case of destruction and regeneration of a continent," 1969]: Geol. Soc. America Bull., v. 81, no. 6, p. 1863-1864, 1970.

In reply to Hatten and Meyerhoff (ibid., p. 1855-1962), Škvor suggests that the discussors failed to touch on the principal problems in their presentation of their own ideas concerning the geology of the region. This reply is primarily directed toward questioning of the idea of the so-called Cuban geosyncline. — VSN

03088 **Slade, D. V.; Gauger, J.; Vali, V.** Laser geophysical strain measurements on Kern River Fault: Modern Geology, v. 1, no. 3, p. 237-246, illus., 1970.

A multicomponent laser strain meter installed across the Kern River Fault in California has yielded information on a wide bandwidth of earth motion. The strains over the fault are amplified relative to those measured on bedrock; this was interpreted as being due to the essentially fluid nature of the material in the fault zone. For underground nuclear tests an offset in strain was observed. It is shown that with a simple two component instrument the location of an explosion can be determined. For earth strains due to tidal action there is close correlation between calculated and observed values. An expected increase in amplitude of microseisms during high wind velocities was detected. — Authors' abstract

03220 **Sloan, Charles E.** Biotic and hydrologic variables in prairie potholes in North Dakota: Jour. Range Management, v. 23, no. 4, p. 260-263, illus., table, 1970.

Prairie potholes, or sloughs, are depressions of glacial origin that occur north of the Missouri River in the prairie region of the United States and Canada. Potholes provide valuable wetland habitat for migratory waterfowl and are widely used for stockwater supplies. Differences in climate, geology, topography, ground-water hydrology, and land use create wide variations in pothole hydrology. Plants in and adjacent to potholes are useful indicators of water permanence, depth, and salinity-variables that are important in wetland management. — Author's abstract

03488 **Sloan, Robert.** A teacher's guide for geologic field investigations in southeastern Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, 19 p., illus., table [n.d.].

This guide, one of eight, is organized so that the general problems and possible investigations are discussed first, each followed by several suggested stops to study these features. Problems involving fossils are presented first. Ordovician fossils in the Twin Cities area are illustrated, and the best collecting localities and most prolific formations are listed. Problems in correlation, evolution, and variation horizontally and vertically are suggested. Other subjects studied include deltas in the Mississippi Valley below Lake Pepin, and problems in geologic history of eastern Goodhue County. An outline of this history is given along with specific localities demonstrating it. — ESL

03422 **Smart, J. S.** Use of topologic information in processing data for channel networks: Water Resources Research, v. 6, no. 3, p. 932-936, illus., table, 1970.

The binary digit representation of channel network topology is proposed as an aid to data handling for channel networks. Examples of its use are drawn from the fields of water pollution control and geomorphology. — Author's abstract

Smith, A. L. *See* Carmichael, I. S. E. 03177

03323 **Smith, A. L.** Sphene, perovskite and coexisting Fe-Ti oxide minerals: Am. Mineralogist, v. 55, nos. 1-2, p. 264-269, tables, 1970.

Analytical data on perovskite, sphene, and their coexisting Fe-Ti oxides are given. Sphene contains high ZrO_2 (up to 3.6 percent), less Nb_2O_5, and small amounts of fluorine. Perovskite is rich in rare earths (up to 7.4 percent), strontium, sodium, and niobium. On the average sphene has 8.2 weight percent minor element substitution, and perovskite 10.8 weight percent. The coexisting titanomagnetites have less than 45 percent Fe_2TiO_4, but may be relatively magnesian (up to 7.0 percent). — Author's abstract

Smith, Bruce D. *See* Hodge, Dennis S. 03713

03199 **Smith, D. G. W.; Tomlinson, M. C.** An APL language computer program for use in electron microprobe analysis: Kansas Geol. Survey Computer Contr. 45, 28 p., illus., tables, 1970.

PROBEDATA is an APL language program for correcting raw X-ray intensity data from an electron microprobe for background, dead-time, atomic number, absorption and characteristic fluorescence effects; it can be used in analysis of any element with atomic number in excess of ten at any integral operating voltages up to 35 KV and will accommodate data for the specimen and several different standards composed of up to 20 elements. The program can manipulate corrected data to calculate structural formulas for minerals, concentrations of elements present but not analyzed, and etc. One restriction is that intensities from M lines cannot be corrected. The program does not provide for input of data in a wide range of formats. — MCM

Smith, George I. *See* Friedman, Irving. 03347

03638 **Smith, J. W.; Schopf, J. William; Kaplan, I. R.** Extractable organic matter in Precambrian cherts: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 659-675, illus., tables, 1970.

Concentrations of hydrocarbons and fatty acids and the ratios of the stable isotopes of C and S were determined for cherts from the Gunflint, Paradise Creek, and Bitter Springs formations. The highest concentrations, recovered from the untreated surfaces of the samples, are probably entirely of recent origin. Extremely small concentrations extracted from interior portions of the Precambrian samples may be in part indigenous to the sediments, but are not demonstrably syngenetic with original sedimentation; the major portion of these extracts also appears to be of relatively recent origin. Microfractures could allow the passage of ground water under a pressure gradient. In the absence of chemical criteria firmly establishing the syngenetic nature of extracted organic constituents, such studies of Precambrian sediments may only provide ambiguous evidence of early biochemical processes. — *from* Authors' abstract

03060 **Smith, Joseph V.** Physical properties of order-disorder structures with especial reference to feldspar minerals: Lithos, v. 3, no. 2, p. 145-160, illus., 1970.

It is proposed that cell dimensions, refractive indices and other physical properties depend more on local than on distant neighbors, and that only if local and distant order are correlated will there be a simple relation between physical properties and electron density distributions measured by X-ray diffraction. Measured values of physical properties also depend on the resolution of the apparatus. For K-feldspar, available data are examined in terms of multiple paths of ordering and of domain texture. The most significant physical properties are b^*, c^*, and 2V; the extinction angle and triclinic geometry have no fundamental significance. For Na-feldspar, MacKenzie's measurements of the triclinic nature of synthetic albite annealed at various temperatures are explained more easily in terms of local than of distant ordering; a critical temperature for distant ordering seems possible. — Author's abstract

03322 **Smith, Marie Lindberg.** Delrioite and metadelrioite from Montrose County, Colorado: Am. Mineralogist, v. 55, nos. 1-2, p. 185-200, illus., tables, 1970.

Single crystal X-ray studies of delrioite from the Jo Dandy mine, Montrose County, Colorado, show that two phases are intimately intergrown with parallel fiber axes. The relative intensities of the pattern of the two phases vary in response to changes in the humidity of the ambient atmosphere. Delrioite is the more hydrous of the phases, and metadelrioite the less hydrous. Data on the crystal structure are given for both phases. — *from* Author's abstract

Smith, William C. *See* Judd, James B. 03721

Smithson, Scott B. *See* Hodge, Dennis S. 03713

03204 **Snell, David E.** Big, big concretions: Pennsylvania Geology, v. 1, no. 6, p. 6-7, illus., 1970.

Interesting aspects of concretions unearthed near Tyrone, Blair County, Pa., are: the relative abundance of those in the four-foot diameter range, perfection or roundness as opposed to irregularly shaped masses, and the relatively clean parting which exists between the concretion and the enclosing shale. Shale in the area has a nearly vertical dip, allowing meteoric water to percolate freely downward along the shale layers, causing solution at the shale-concretion interface, in contrast to concretions found in black shales of the coal regions where there is no sharp transition between the concretion and the enclosing shale. When a concretion forms in sediments having nearly isotropic qualities with regard to movement of solution, it is likely to be spherical; if media is anisotropic, flattened shapes result as in these "Tyrone" concretions which are often oblate spheroids. — MCM

03382 **Snell, L. J.; Anderson, Warren.** Water resources of northeast Florida (St. Johns River basin and adjacent coastal areas): Florida Bur. Geology Rept. Inv. 54, 77 p., illus., tables, 1970.

Rapid industrial expansion and population growth place increasing demands on water resources of the area that comprises one-fifth the land area of Florida and contains one-fourth its population. Ground water from the Floridan aquifer, which underlies the entire area, is the principal source of water for all uses except cooling water used in generation of electric power and some industrial processes. Some water is obtained from sand or sand and shell aquifers occurring above the Floridan. Wells in the Floridan may yield more than 5,000 gpm; quality of water varies from good in or near recharge areas to poor along the St. Johns River and near the coast. Moderate amounts of good quality water can be obtained from shallow aquifers along the coast. The supply of water is ample, but problems are those of distribution and contamination. — *from* Authors' abstract

03320 **Snyder, George L.** Bedrock geologic and magnetic maps of the Marlborough quadrangle, east-central Connecticut: U.S. Geol. Survey Geol. Quad. Map GQ-791, 2 sheets, scale 1:24,000, sections, separate text, 1970.

A magnetometer survey of Marlborough quadrangle indicates a complex series of en echelon dikes which are potentially valuable sources of road metal; available aeromagnetic data suggest the dike pattern continues south and northeast. Ground measurements were extended in traverses across aeromagnetic highs related to Monson and Middletown Gneisses. The belt of Monson Gneiss generally has a positive magnetic anomaly; relatively low areas also occur within this belt and no single gamma reading would necessarily indicate subjacent Monson Gneiss. Petrographic study of Glastonbury Gneiss indicates these rocks change imperceptibly from outcrop to outcrop, and many different internal phases merge gradually with one another over large distances. The Ordovician Daly Swamp Member is introduced as a medial member of Brimfield Schist having calc-silicate affinities. Structure of the area includes a possible fault, evidence for three unconformities, and numerous folds. — MCM

03577 **Sobolev, V. S.; Bararova, T. Y.; Shugurova, N. A.; Bazarov, L. Sh.; Dolgov, Yu. A.; Sörensen, H.** A preliminary examination of fluid inclusions in nepheline, sorensenite, tugtupite and chkalovite from the Ilímaussaq alkaline intrusion, South Greenland [with Russian abs.]: Medd. Grönland, v. 181, no. 11, 33 p., illus., tables, 1970; *reprinted as* Grönlands Geol. Undersögelse Bull. 81, 1970.

Primary three-phase inclusions (liquid-gas-crystals) in nepheline from naujaite homogenize in the liquid phase at 850-1040°C. Primary gas-liquid inclusions in nepheline from green lujavrite homogenize at 910-970°C in the liquid phase; those in sorensenite and tugtupite from late analcime-albite veins homogenize at 400-460°C. The liquid phase of fluid inclusions in tugtupite contains 21 weight percent of salts. Secondary fluid inclusions in the latter two minerals homogenize at 350-100°C. A crystal of chkalovite from an ussingite-analcime vein contains several generations of fluid inclusions. Primary liquid-gas-crystal inclusions homogenize at 860-980°C; the

solid phase is dissolved at 330-360°C; two immiscible liquids appear at 700-800°C. Half of the 250 fluid inclusions examined belong to this category. The several generations of secondary inclusions homogenize in several groups between 760 and 100°C. — *from* Authors' abstract

Solomon, M. *See* Dunham, K. C. 03588

03303 **Solomon, Sean C.; Toksöz, M. Nafi.** Lateral variation of attenuation of P and S waves beneath the United States: Seismol. Soc. America Bull., v. 60, no. 3, p. 819-838, illus., tables, 1970.

New observations of the differential attenuation of long period S waves, measured using a spectral ratio technique, and a re-examination of reported attenuation measurements for P waves indicate significant lateral variations in attenuation beneath the United States. High attenuation is observed at stations between the Rocky Mountains and the Sierra Nevada-Cascade ranges and in the northeast United States. Low attenuation is seen at stations in the central and eastern parts of the country and along the Pacific coast. Relative magnitudes of S- and P-differential attenuation are consistent with P-wave absorption being due entirely to losses in shear. A large azimuthal dependence for near-source attenuation is suggested for an earthquake on a mid-ocean ridge. — Authors' abstract

Sörensen, H. *See* Sobolev, V. S. 03577

Sörensen, H. *See* Petersilie, I. A. 03711

03516 **Sörensen, Kai.** Some observations on the structural and metamorphic chronolgy on Agto and surrounding islands, central West Greenland: Grönlands Geol. Undersögelse Rap. 27, 32 p., illus., table, 1970.

In granulite facies in the Precambrian Nagssugtoqidian orogenic belt are various acidic gneisses and two mafic groups of amphibolites, old concordant and younger discordant dikes. In the Agto area four structural complexes are outlined, their axial-plane orientations related to deformations of different times, the youngest typical of the regional ENE-trend. Later than at least two phases of folding, discordant metabasites cut migmatitic structures, so they are younger than at least one period of high-grade metamorphism; predating the youngest ENE-striking folds, they are older than that high-grade metamorphism which, partially contemporaneous with the Nagssugtoqidian deformation, converted basic dikes into pyroxene amphibolites. If intrusion of basic dikes, into rocks affected by tensional stresses, marks a major interval between the youngest and earlier orogenic episodes, all rocks of this area are pre-Nagssugtoqidian. — *from* Author's abstract

03617 **Sorey, Michael L.; Matlock, William G.** Evaporation from an ephemeral streambed — Closure [to discussion of paper 6368, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 6, p. 1354-1355, 1970.

Paper 6368 was published *in* ibid., v. 95, no. HY 1, p. 423-438, 1969; *see* Abs. North American Geology, June 1969.

Spangler, D. P. *See* Wallace, D. E. 03639

03463 **Spector, Allan.** Deep uranium exploration with the aid of aeromagnetic maps [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 291, 1970.

03539 **Spinosa, Claude; Furnish, W. M.; Glenister, Brian F.** Araxoceratidae, Upper Permian ammonoids, from the Western Hemisphere: Jour. Paleontology, v. 44, no. 4, p. 730-736, illus., table, 1970.

An ancestral araxoceratid is described: *Eoaraxoceras ruzhencevi*, n.gen., n.sp., from the uppermost Guadalupian (Amarassian) La Colorada beds of the Valle de las Delicias, Coahuila, Mexico. This occurrence, in the youngest Permian exposures of Coahuila, is the first record of Araxoceratidae in the Western Hemisphere and pro-

vides the phyletic link between the well-known Guadalupian Paraceltitinae and the advanced Araxoceratidae of the Late Permian Dzhulfian succession in Soviet and Iranian Azerbaidzhan. — REG

03132 **Srivastava, Satish K.** Pollen biostratigraphy and paleoecology of the Edmonton Formation (Maestrichtian), Alberta, Canada: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 7, no. 3, p. 221-276, illus., 1970.

Nine pollen assemblage zones and three subzones based principally on angiosperms, are recognized within 840 feet of this Upper Cretaceous formation. Angiosperm assemblages show major breaks at onset of Drumheller marine tongue, at base of the mauve-shale containing Kneehills Tuff, and at top of Nevis Coal Seam. Brackish deposition of basal beds followed regression of the Campanian Bearpaw Sea; the subtropical humid climate supported a rain-forest-type vegetation. Following the Drumheller marine episode, many tropical and subtropical angiosperms disappeared. Temperate and warm temperate elements and increasing numbers of gymnosperms and pteridophytes indicate a humid subtropical climate with warm temperate aspect until deposition of mauve-shale beds, which represent lacustrine deposition with cooler climate and savanna-type vegetation. Above this shale, sediments are of flood plain origin and flora denotes a warm temperate climate. — *from* Author's abstract

Stadum, Carol J. *See* Ling, Hsin-Yi. 03650

Stafford, Donald B. *See* Langfelder, Leonard J. 03718

03759 **Stanton, Robert J., Jr.** Paleoecology of Claiborne shales, *in* Outcrops of the Claiborne Group in the Brazos Valley, southeast Texas — Geol. Soc. America South-Central Sec., 4th Ann. Mtg., 1970, Guidebook: [College Station, Tex.] Texas A and M Univ., Dept. Geology, p. 22-25, 1970.

Lithologic characteristics of Eocene shales represented by outcrops of the Stone City beds on the Brazos River and the Crockett Formation on the Little Brazos River, near College Station, Texas, are reviewed. Various paleontological and sedimentological criteria are described for environmental interpretation and interpretations of various authors are given of the depositional environment of the two stratigraphic intervals. It is concluded that an integrated analysis, using all of these criteria and methods, and data gathered with thoroughness should provide reliable interpretations. Sedimentation models can be a valuable tool. Faunal diversity as well as adaptive functional morphology would be the most promising paleontological criteria. — EH

03555 **Starkey, J.; Wainwright, J. E. N.** Ueber die Struktur des Tiefalbits aus Kluften in den Glaukophanschiefern Kaliforniens [abs.]: Fortschr. Mineralogie, v. 47, no. 1, p. 64-65, 1970.

03270 **Staub, William Praed.** Seismic refraction, a technique for subsurface investigation in Iowa [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5108B, 1970.

03310 **Stauder, William; Nuttli, Otto W.** Seismic studies — South central Illinois earthquake of November 9, 1968: Seismol. Soc. America Bull., v. 60, no. 3, p. 973-981, illus., tables, 1970.

The south-central Illinois earthquake of November 9, 1968, was the largest in this century in the central Mississippi seismic region. Observations from 12 stations 171 to 549 km away indicate focal coordinates at 37.95° N., 88.48° W., h = 25 km, 0 = 17^h01^m42.0 ± 0.2^s. P-wave traveltimes indicate regional mantle variations down to 650 km. P times fit two straight line branches, corresponding to Pn and to rays refracted from an 8.37-kmps surface at 97 km. Body-wave magnitude was 5.54 ± 0.44 for stations at $\Delta > 25°$, and 5.44 ± 0.29 for Pn in eastern North America; surface waves give a value $M_s = 5.2$. The fault plane solution corresponds to dip slip, reverse motion, and a horizontal east-west axis of compressional stress, which is consistent with motion along the Wabash Valley Fault System. — DBV

03311 **Stauder, William; Pitt, Andrew M.** Note on an aftershock study, south central Illinois earthquake of November 9, 1968: Seismol. Soc. America Bull., v. 60, no. 3, p. 983-986, illus., tables, 1970.

In an effort to monitor aftershock activity following the southern Illinois earthquake of November 9, 1968, a network of ten high gain seismic stations was established in the vicinity of the epicenter of the earthquake. The network began recording on the fourth day after the earthquake and operated for a period of ten days. During this time only one very small aftershock was recorded. The hypocenter of this shock was about 10 km south and at the same depth as that of the main shock. Permanent stations of the region recorded two other aftershocks within two days of the main shock, and one more three and a half months later. The exceptionally low level of aftershock activity is an anomalous feature of the Southern Illinois-Southeast Missouri seismic zone. — Authors' abstract

03691 **Stehli, Francis G.** A test of the Earth's magnetic field during Permian time: Jour. Geophys. Research, v. 75, no. 17, p. 3325-3342, illus., 1970.

Quantitative paleontologic data sensitive to the planetary temperature gradient are used with similar data for living organisms to test two possible Permian latitude models for the Northern Hemisphere. Results indicate that the present-earth latitude model could be correct for the Permian but do not prove that this is so because data are sparse, the noise level is relatively high, and neither North America nor Eurasia contains the equator for this model of the Earth. The Permian paleomagnetic models tested are as inappropriate for the Permian as for the Recent data. The fact that the paleomagnetic models are found inappropriate indicates that (1) the paleontological data are inadequate, (2) the paleomagnetic model used is not correct because data needed to define it are lacking in large areas, or (3) the Permian magnetic field was not axial. — *from* Author's abstract

03045 **Steinbrugge, Karl V.** Earthquake damage and structural performance in the United States, Chap. 9 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 167-226, illus., tables, 1970.

A brief review is given of earthquake damage patterns in the United States with a summary of damage statistics, to point out a few critical areas in building design, and to show the bases for judgment required in competent earthquake resistive design. The earthquake provisions of a building code plus the design engineer's judgment normally determine the seismic risk for any particular building or structure. However, the seismic risk may be quite different for life than for property. Earthquakes discussed were chosen for their significance to American earthquake engineering practice and are case histories of various aspects of seismic risk. Twenty-four earthquakes are examined and summarized in a table; except for the New Madrid, Mo., and Charleston, S.C., earthquakes are all 20th century events in California, Montana, Washington, Nevada, and Alaska. The importance to design engineers of knowledge of active faults with surface expression is summarized briefly. — VSN

03134 **Stephenson, Richard A.** On the use of grain size analysis in geomorphological studies: Prof. Geographer, v. 22, no. 4, p. 200-203, illus., table, 1970.

The importance of grain size analysis can be found in the varied responses of landform to sedimentary controls. The distinction of sediment age, source area, and process at the time of deposition must be considered. The presentation here has emphasized the apparent relationship between grain characteristics and mode of deposition on certain landforms. Studies in stream deposition, coastal and estuarine processes and glacial deposits can also be important in ascertaining the age and the source of sediments. The establishment of the functional relationship between landform and sediment characteristics in geographic literature is meager. Some studies have been accomplished which compare land morphometry with various sedimentary covers. However, actual grain size analysis of the sediments has not been done. The use of such analysis can aid the investigator in reaching more valid results in the study of landforms. — Author's summary

Stevens, R. D. *See* Boyle, R. W. 03478

03150 **Stevenson, I. M.** Rigolet and Groswater Bay map-areas, Newfoundland (Labrador): Canada Geol. Survey Paper 69-48, 24 p., geol. map, 1970.

The northwestern part of the area is underlain by sedimentary and volcanic rocks of the Aillik Group, tightly folded into a series of northeast-striking folds and intruded by granitic and gabbroic rocks. The Aillik Group, of probable early Aphebian age, represents some of the oldest rocks in the area, and grades into basement Archean rocks represented by the Hopedale Gneiss. Age determinations indicate that the granitic rocks of Benedict Mountains may have been emplaced during the Hudsonian. The southern part is underlain by quartzofeldspathic gneisses and intrusive granitic and gabbroic rocks, possibly of late Aphebian age, cut by gabbroid dykes and stock-like bodies of Helikian age, probably emplaced during the Grenville Orogeny. Uranium mineralization, probably of considerable economic importance, occurs widely throughout rocks of the Aillik Group. Several showings of base metals were found. — *from* Author's abstract

03147 **Stevenson, Robert E.** Gross transport of suspended sediments over continental shelves as analyzed from Gemini and Apollo space photography [abs.]: Corpus Christi Geol. Soc. Bull., v. 10, no. 9, p. 4, 1970.

03112 **Stevenson, Robert Louis.** The effects of a supplementary programmed textbook on transfer of training to particular geologic interpretations — An experimental study [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4665B, 1970.

Stewart, J. M. *See* Petruk, W. 03494

Stewart, J. M. *See* Cabri, L. J. 03500

Stewart, J. W. *See* Cherry, R. N. 03383

03380 **Stewart, John H.** Upper Precambrian and Lower Cambrian strata in the southern Great Basin, California and Nevada: U.S. Geol. Survey Prof. Paper 620, 206 p., illus., tables, 1970.

Initial deposits in the Cordilleran geosyncline, structurally complex quartzites, siltstones and carbonate strata, here form a wedge that thickens from 400 feet in the east to about 21,000 feet 175 mi to the northwest. They lie with angular conformity on strongly folded metamorphic rocks 1.1-1.8 b.y. old, and are conformably overlain by Middle Cambrian and younger strata. Upper Precambrian and Lower Cambrian formations are described by eastern, central, and western regions, in each of which nomenclature reflects lateral differences in similar lithology. Widespread uniformity of composition, thickness, and stratification, and shallow-water fauna support probable accumulation on a marine shelf. Generally westward current directions in cross-strata studies, and composition of sediments indicate an eastern source in a cratonic lower Precambrian terrane with associated granitic and pegmatite bodies. — GDC

Stewart, Ronald C. *See* Walker, William R. 03058

03156 **Stone, D. S.** Principal horizontal stress in the central Rocky Mountains versus California: Mtn. Geologist, v. 7, no. 2, p. 69-82, illus., 1970.

In the central Rocky Mountain area, principal horizontal stress (PHS) was probably oriented nearly east-northeast and west-southwest throughout most of the area's deformational history. In California, on the other hand, PHS orientation is now nearly north-south, but was probably essentially parallel to that in the central Rockies in pre-middle Eocene time. It is postulated, therefore, that the difference in the present orientation of structures in these two provinces is a result of a counterclockwise rotation of PHS in California during the Tertiary, that is, from the Laramide direction to the present north-south direction. According to this hypothesis, the anomalous relationship between the San Andreas right wrench and Garlock left wrench fault sets in California can be interpreted to indicate that the left wrench set is older than the right wrench set and possibly of Laramide origin. — Author's abstract

03489 **Stone, John.** A teacher's guide for geologic field investigations in the Twin Cities area: [St. Paul, Minn.] Minnesota Dept. Education, 18 p., illus., table [n.d.].

The Minneapolis-St. Paul area is covered by glacial and postglacial deposits ranging from a few to 500 feet thick. Bedrock exposed in river valleys in the southeast is Cambrian-Ordovician, warped to form the Twin Cities basin; small faults are common. A network of valleys mostly buried, cuts the bedrock. Glacial and lake deposits, mostly of Wisconsin age, are described, and geologic units and aquifers are tabulated and shown in a cross section; a map of bedrock topography is included. Features studied at eight stops are: a perched outwash plain, glacial units and ice-shove structures, mixing of two tills, origin and history of Minnehaha Falls, displaced blocks of the Platteville Formation, drift-covered bedrock hill, terraces and valley-train deposits along the St. Croix River, and lake deposits in Little Canada. — ESL

03172 **Stormer, J. C., Jr.; Carmichael, I. S. E.** Villiaumite and the occurrence of fluoride minerals in igneous rocks: Am. Mineralogist, v. 55, nos. 1-2, p. 126-134, illus., 1970.

The first occurrence of villiaumite (NaF) in the United States has been discovered in Colfax County, New Mexico, where it is found in a peralkaline phonolitic sill. Electron-probe analysis of this sample and of samples from Guinea and U.S.S.R. shows only limited substitution of Al and also suggests that published analyses showing substantial substitution of other elements (K, Ca) in villiaumite are likely to be in error. Thermodynamic calculations show that fluorite is to be expected as the common fluoride mineral in both silica-saturated and under-saturated igneous rocks; in calcium- and silica-poor assemblages villiaumite is favored, but in calcium-poor quartz-bearing rocks, cryolite will prevail. — *from* Authors' abstract

03645 **Stott, Donald F.** The southern Interior Plains, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 191-194, 1970.

This region lies between the Precambrian Shield and the eastern Cordillera and extends from the international boundary to the 60th parallel. It includes parts of Manitoba, Saskatchewan, Alberta, and the northeast corner of British Columbia. Oil and natural gas are the major mineral resources of the prairie provinces, with potash and sulfur second. The history of geologic exploration is reviewed, and a summary of the present level of knowledge and activities is given. Most favorable areas will be selected on the basis of geology, with geophysics aiding in finding specific locations; integrated studies are needed. Objectives and future trends are discussed. — ESL

03486 **Stow, S. H.** Arsenic in phosphorite and apatite — A reply [to 1970 discussion by D. McConnell of 1969 paper]: Econ. Geology, v. 65, no. 1, p. 65-66, 1970.

For original paper, *see* ibid., v. 64, no. 6, p. 667-671, 1969; Abs. North American Geology, April 1970.

Strangway, David W. *See* Saint Amant, M. 03737

03473 **Strick, E.** A predicted pedestal effect for pulse propagation in constant-Q solids: Geophysics, v. 35, no. 3, p. 387-403, illus., table, 1970.

Assuming almost constant-Q behavior of solids over a wide range of frequencies together with assumptions on behavior of the attenuation function, expressions are obtained for waveform distortion of an impulse-excited plane wave as it decays and spreads on passing through large distances of a solid. When typical values for parameters for a solid having a mechanical Q of about 50 are used, resulting waveforms have a simple and expected behavior. However, the waveform part leading up to visible onset does not admit of purely elastic interpretation, so that arrival time cannot be related conceptually with a purely elastic-wave velocity. About 1/7 of arrival-time duration is due to purely inelastic behavior; during this period amplitude is deceptively small. This portion is designated a "pedestal." Although the pedestal may not be significant in exploration or earthquake records, an upward curvature not associated with a discontinuity in slope at time of visual onset will remain and can be of importance in very accurate arrival-time measurements. — DBV

03727 **Strimple, Harrell L.; McGinnis, Michael R.** A new platycrinitid from Gilmore City, Iowa: Iowa Acad. Sci. Proc. 1969, v. 76, p. 263-266, illus., 1970.

A recently discovered crinoid from the Gilmore City Formation, Kinderhookian Stage, Lower Mississipian age, is in excellent preservation and is an undescribed species belonging to a highly specialized group within the genus *Platycrinites*. Charles F. Crane, of Ames, Iowa, the collector, realized the scientific importance of the specimen and allowed it to be described and reposited in the Repository, Department of Geology, The University of Iowa, Iowa City. The species is named *Platycrinites cranei* Strimple and McGinnis, new species, named for Charles F. Crane. Description and comparison with related species from Montana and southeastern Iowa is made. — Authors' abstract

03221 **Styra, B. I.; Nedveckaite, T. N.; Senko, E. E.** New methods of measuring thoron (radon 220) exhalation: Jour. Geophys. Research, v. 75, no. 18, p. 3635-3638, illus., tables, 1970.

Two methods of measuring Rn-220 exhalation, by disintegration chamber and by nuclear emulsion, are described. The data on the Rn-220 exhalation under various weather conditions and states of ground surface are summarized. The average values range from zero, when the snow surface is covered by ice, to 33×10^{-16} curie per sq cm sec for dry ground in summer. — Authors' abstract

03461 **Suffel, G. G.; Hutchinson, R. W.; Ridler, R. H.** Metallogenic relationships in Archean rocks [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 289, 1970.

03063 **Sumsion, C. T.; Bjorklund, L. J.; Bolke, E. L.; Mower, R. W.; Herbert, L. R.; Cordova, R. M.; Butler, R. G.; Sandberg, G. W.** Ground-water conditions in Utah, spring of 1970: Utah Div. Water Resources Coop. Inv. Rept. 8, 71 p., illus., tables, 1970.

Estimated total withdrawal from wells in Utah during 1969 was about 670,000 acre-feet, about 40,000 acre-feet more than for 1968; although all types of withdrawal except public supply increased, water levels generally rose from March 1969 to March 1970 as a result of above-normal precipitation. Discussion by individual authors summarizes ground-water development and changes in ground-water conditions in the major areas of development: Cache, Jordan, Tooele, Utah and Goshen, Juab, Sevier, Sanpete, Pavant, Cedar City, Parawan, and Escalante Valleys; East Shore area; and Sevier Desert. — MCM

Sundara Raja Iyengar, K. T. *See* Narayana Iyengar, R. 03203

Swanberg, Chandler A. *See* Menzer, Fred J., Jr. 03403

03059 **Swann, D. H.; DuMontelle, P. B.; Mast, R. F.; VanDyke, L. H.** ILLIMAP, a computer-based mapping system for Illinois: Illinois Geol. Survey Circ. 451, 24 p., illus., table, 1970.

ILLIMAP, a computer-based system designed to construct maps of any portion of the state, at any scale, with a high degree of accuracy, can also convert locations expressed in section-township-range notation into rectangular coordinates that can then be used to plot maps with an incremental plotting machine. The system has been designed to help the Survey present geologic and mineralogic data; however, it may be useful to those outside the Survey who wish to construct maps of Illinois or to create a similar mapping system. — *from* Authors' abstract

03667 **Swanson, Vernon E.** Reconnaissance for dam sites in remote areas: Am. Soc. Civil Engineers Proc., v. 96, paper 7244, Jour. Surveying and Mapping Div., no. SU1, p. 97-111, illus., 1970.

River reconnaissance studies generally separate into three stages — literature search, interviews with knowledgeable people, and field investigations. Before going into the area the engineer-geologist team should make an aerial reconnaissance. Aerial and ground reconnaissance information must be carefully observed, recorded and illustrated because the trip will probably never be repeated. The team will use field notes,

sketches, marked-up maps, photographs and tape-records to record field information. The Trip Report, consisting of a series of site reports, should be reviewed by the client before the team leaves the field. A standard format for each site report would be: a compressed main report with recommendations; an appendix containing copies of pertinent field notes; a file with all the original field notes. — *from* ASCE abstract

03292 **Swift, Donald J. P.; Pirie, R. Gordon.** Fine-sediment dispersal in the Gulf of San Miguel, western Gulf of Panama, a reconnaissance: Jour. Marine Research, v. 28, no. 1, p. 69-95, illus., tables, 1970.

This estuary of eastern Panama has a deep central scour channel, flanked by semicircular bays. In the upper Gulf and tributary estuaries, near to fresh-water input, with turbulence over irregular shoaling, water structure is heterogeneous, varying with salinity fronts. In size-frequency distributions of suspended sediments, measured *in situ*, median hydraulic diameters correlate with depth and current velocity. Sediments resuspended, as shoals are flooded, have log-normal size-distributions whose plotted curves are straight lines; as current strength wanes beyond the shoal, distributions are coarse-truncated. Among elements in the dispersal system, marginal lutite prisms serve as mud reservoirs, which exchange material with overlying water mass during every tide cycle; not in equilibrium, they prograde toward the central channel. — GDC

03745 **Swift, Donald J. P.; Pelletier, Bernard R.; Lyall, Anil K.; Miller, James A.** Sediments of the Bay of Fundy, a preliminary report: Maritime Sediments, v. 5, no. 3, p. 95-100, illus., 1969 [1970].

Bottom sampling in the Bay of Fundy in 1961-66 on a 2-km grid has shown its sediments are in textural provinces of three main facies groups: gravel over most of the floor, presumably relict Pleistocene; sand on southwest and northeast from late Pleistocene outwash of a periglacial river or meltwater from a former ice cap on southern Nova Scotia; and mud along northeast side, localized by weaker tidal and counterclockwise residual currents. Suspended sediments reflect oscillating turbid water, substrate exchange with overlying water mass, minor fresh input, and minor salt water output into the Gulf of Maine. On the south side is a long-term transfer of fine material, winnowed from the Quaternary bottom sediment, much of it carried to aggrading mud facies on the northwest, and settled during slack tides. — GDC

03185 **Tamers, M. A.** Instituto Venezolano de Investigaciones Científicas natural radiocarbon measurements V: Radiocarbon, v. 12, no. 2, p. 509-525, table, 1970.

Tanner, W. F. *See* Niedoroda, A. W. 03704

03756 **Tavenas, F.; Capelle, J. F.; LaRochelle, P.** Étude des sables submergés par échantillonnage non remanié [Study of submerged sand by undisturbed sampling (with English abs.)]: Canadian Geotech. Jour., v. 7, no. 1, p. 37-53, illus., tables, 1970.

The aim of this paper is to present a method of investigation of submerged sand deposits based on undisturbed sampling by an ancient but not widely used technique. After a rapid description of the equipment and technique, three case histories where this method was used are considered [Manicouagan River dam 3, Chicoutimi bridge on the Saguenay River, and regulation of the St. Charles River at Quebec]. These lead to some important remarks concerning the quality of the samples, the limits of applicability of the method, and finally the validity of the well-known relationships between standard penetration index and relative density, friction angle, or modulus of elasticity of sands. — Authors' abstract

03640 **Taylor, G. J.; Heymann, D.** Electron microprobe study of metal particles in the Kingfisher meteorite: Geochim. et Cosmochim. Acta, v. 34, no. 6, p. 677-687, illus., 1970.

Ni, Fe, and P contents were determined with an electron microprobe in five metal particles of the Kingfisher chondrite. These particles show microstructures which can best be described as very coarse plessites. The results indicate that the microstruc-

tures were formed by the transformation of preexisting α_2-phase. In the case of Kingfisher the transformation occurred when the meteorite was reheated by shock, some 500 m.y. ago. Most of the α_2-phase was then transformed at about 600°C. If this is taken to be the residual temperature of the silicates, the shock pressure was at least 0.5 Mb. The evidence suggests that the α_2 decomposition was completed at about 450°C. The grain size of the taenite seems to imply rather slow cooling after the shock; at least some tens of years at 600°C are required for the largest grains. — Authors' abstract

Taylor, Gordon C. *See* Norris, D. K. 03477

Taylor, H. C. *See* Menzer, Fred J., Jr. 03403

03723 **Taylor, L. A.** The system Ag-Fe-S, phase equilibria and mineral assemblages [with German abs.]: Mineralium Deposita, v. 5, no. 1, p. 41-58, illus., tables, 1970.

Experimental procedures are described briefly and previous work on the Ag-S, Fe-S, Ag-Fe, and Ag-Fe-S systems reviewed. Phase relations in the last are described starting at 700°C and proceeding downward. The development of tie lines between Ag_2S and $Fe_{1-x}S$, and Ag_2S and FeS_2, and of the $Ag_2S + FeS_2 + Fe_{1-x}S$ field are discussed. Also discussed are ternary solid solutions of binary phases, effect of Fe on Ag_2S inversions and $Fe_{1-x}S$ compositions in ternary assemblages. Phase relations between 320° and 200°C, and below 200°C are included. Experiments were done with natural sternbergite and argentopyrite. Argentiferous pyrite is wrongly named as the amount of silver in solid solution is too small to influence cell dimensions. A minimum-temperature indicator is provided by the assemblage arg-po. The silver-pyrite assemblage is important in the Kidd Creek massive sulfide deposit in Ontario. — ESL

03596 **Thompson, Allan M.** Geochemistry of color genesis in red-bed sequence, Juniata and Bald Eagle Formations, Pennsylvania: Jour. Sed. Petrology, v. 40, no. 2, p. 599-615, illus., tables, 1970.

Geochemical and stratigraphic data indicate that the difference in color between the Upper Ordovician red Juniata and underlying drab (gray-green) Bald Eagle Formations in central Pennsylvania is of secondary, diagenetic origin. The color boundary separating the two sandstones cuts across lithofacies boundaries, and varies more than 700 feet in vertical position. Data suggest that red hematite pigment was diagenetically removed from the lower portions of an initially all-red sequence by aqueous reduction and dissolution, with generation of iron-rich clay-mineral phases stable in a saturated environment. — *from* Author's abstract

03365 **Thompson, G.; Livingston, H. D.** Strontium and uranium concentrations in aragonite precipitated by some modern corals: Earth and Planetary Sci. Letters, v. 8, no. 6, p. 439-442, table, 1970.

Ahermatypic corals, and hermatypic corals without zooxanthellae, have Sr and U concentrations that are greater than those of reef corals containing zooxanthellae. The Sr and U concentrations in the coral are independent of water temperature, in that respect differing from those in aragonite experimentally precipitated from sea water in the laboratory. The deposition of Sr and U in scleractinian coral aragonite may be related to coral metabolic processes and to the influence of algal photosynthesis calcification rates. — Authors' abstract

03113 **Thomsen, Leon.** On the fourth-order anharmonic equation of state of solids [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4665B, 1970.

Thomson, F. H. *See* Wasson, B. E. 03141

03163 **Thorstenson, Donald C.** Equilibrium distribution of small organic molecules in natural waters: Geochim. et Cosmochim. Acta, v. 34, no. 7, p. 745-770, illus., tables, 1970.

The equilibrium activities of 39 dissolved species in the system C-N-S-H_2O are computed as a function of pe and pH at 25°C. For pe-pH conditions encountered in natural waters the predominant dissolved species are listed, with a note that organic compounds of higher molecular weight than those listed are usually thermodynamically unstable under these conditions. The distribution of dissolved species is computed for the decomposition reactions of carbohydrates and alanine in sea water; also, a mathematical expression for the homogeneous pe buffer capacity is derived. Data from five reducing marine environments show that the predominant dissolved species tend to equilibrium, with the exception that the concentration of dissolved methane in certain environments is considerably higher than the predicted equilibrium concentration. — GV

03017 **Thyssen, F.** Bernhard Brockamp [1902-1968]: Polar Rec., v. 15, no. 94, p. 77-78, 1970.

03526 **Thyssen-Bornemisza, Stephen.** Discussion on "Variations of vertical gravity gradient in New York City and Alpine, New Jersey", by John T. Kuo, Mario Ottaviani, and Shri K. Singh (Geophysics, April 1969, p. 235-248): Geophysics, v. 35, no. 3, p. 521-522, table, 1970.

For the paper under discussion, *see* ibid., v. 34, no. 2, p. 235-248, 1969; Abs. North American Geology for November 1969.

03452 **Tidwell, William D.; Rushforth, Samuel R.** *Osmundacaulis wadei*, a new osmundaceous species from the Morrison Formation (Jurassic) of Utah: Torrey Bot. Club. Bull., v. 97, no. 3, p. 137-144, illus., 1970.

A new species of *Osmundacaulis*, *O. wadei* from the Jurassic Morrison Formation of southeastern Utah, is described. This new *Osmundacaulis* is characterized by having a small number of xylem strands in the stele. The form is also distinctive in having a cluster of sclerotic cells generally flattened along the adaxial opening of the curved xylem trace and in having a large round cellular mass of sclerenchyma in the stipular wing. *O. wadei* is compared with other members of the *O. herbstii* group to which it appears to belong. This is the first structurally-preserved rhizome of *Osmundacaulis* to be described from the Jurassic of North America and the second reported from Jurassic strata from the Northern Hemisphere. — Authors' abstract

03467 **Tikkanen, G. D.** Results of deeply penetrating geophysical surveys in Manitoba [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 295, 1970.

03124 **Tillman, John R.** The age, stratigraphic relationships, and correlation of the lower part of the Olentangy Shale of central Ohio: Ohio Jour. Sci., v. 70, no. 4, p. 202-217, illus., table, 1970.

The Olentangy Shale of central Ohio (Delaware County) is made up of two distinct stratigraphic units separated by an unconformity. The upper Olentangy Shale is Upper Devonian in age, and is both lithologically and paleontologically distinct from the Lower Olentangy Shale, which is Middle Devonian (Hamilton) in age. The age distinction is based primarily on a comparison of the ostracod faunas. Other invertebrates from the lower Olentangy Shale also suggest a Middle Devonian age. The lower Olentangy Shale correlates with the lower of the exposed units of the Plum Brook Shale of northern Ohio. Most of the invertebrate species of the lower Olentangy Shale, as well as several ostracod species from the Plum Brook Shale, are illustrated. — Author's abstract

03114 **Tobin, Don Graybille.** Microscopic criteria for defining macroscopic modes of deformation in experimentally deformed oolitic limestone [abs.]: Dissert. Abs. International, Sec. B, Sci. and Eng., v. 30, no. 10, p. 4666B, 1970.

03618 **Toffaleti, Fred B.** Definitive computations of sand discharge in rivers — Closure [to discussion of paper 6350, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Hydraulics Div., no. HY 6, p. 1352-1353, 1970.

Paper 6350 was published *in* ibid., v. 95, no. HY 1, p. 225-248, 1969; *see* Abs. North American Geology, June 1969.

Toksöz, M. Nafi. *See* Solomon, Sean C. 03303

Tomlinson, M. C. *See* Smith, D. G. W. 03199

Tornberg, Gordon F. *See* Wiegel, Robert L. 03719

03702 **Traverse, A.; Ames, H. T.** (compilers). Catalog of fossil spores and pollen — V. 32, Devonian spores: University Park, Pa., Pennsylvania State Univ. Palynol. Labs., 344 p., illus., 1970.

This volume contains descriptions of 24 new genera, 147 new species, and 3 new infraspecific taxa, as well as new combinations and emended genera and species; these appeared in 14 publications, dated 1959 to 1967, on spores from Australia, Belgium, Canada, Spitzbergen, Scotland, and Oklahoma. The papers on Canada describe: 6 new megaspore species in 5 genera (2 new, *Nikitinsporites*, *Ocksisporites*), Upper Devonian, Ellesmere Island (Chaloner, 1959); 22 new species in 12 genera (2 new, *Circumsporites*, *Hystrichosporites*), Frasnian, Melville Island (McGregor, 1960); 4 new species of *Emphanisporites*, n.gen., Lower Devonian, southeastern Ontario and Gaspe, Quebec (McGregor, 1961); *Perforosporites robustus* n.gen., n.sp., Lower Devonian, Gaspé, Quebec (Scott and Rouse, 1961). *Quisquilites buckhornensis* n.gen., n.sp., possibly a tasmanitid alga, is described from the Woodford Formation, Oklahoma (Wilson and Urban, 1963). — VMJ

03032 **Trifunac, M. D.; Hudson, D. E.** Analysis of the station no. 2 seismoscope record, 1966, Parkfield, California, earthquake: Seismol. Soc. America Bull., v. 60, no. 3, p. 785-794, illus., 1970.

During the 1966 Parkfield, California, earthquake a strong motion accelerograph and an adjacent seismoscope were located essentially at the causative fault. The accelerograph component parallel to the fault malfunctioned and left no recorded trace. The seismoscope record and the component of the ground motion perpendicular to the fault are used to reconstruct the acceleration component in the direction parallel to the fault. The details of the derived acceleration parallel to the fault differ from the past recorded strong ground motions in that higher frequency components are present. The peak ground accelerations transverse and along the fault are found to be of the same order of magnitude. — Authors' abstract

03356 **Trifunac, Mihailo D.; Brune, James N.** Complexity of energy release during the Imperial Valley, California, earthquake of 1940: Seismol. Soc. America Bull., v. 60, no. 1, p. 137-160, illus., tables, 1970.

The pattern of energy release during the 1940 Imperial Valley, Calif., earthquake is studied by analyzing the El Centro strong motion seismograph record and records from the Tinemaha seismograph station, 546 km from the epicenter. The earthquake was a multiple event sequence with at least four events recorded at El Centro in the first 25 sec, followed by nine events recorded in the next 5 min. Clear P, S, and surface waves were observed on the strong motion record. Although the main part of the earthquake energy was released in the first 15 sec, some later events were as large as $M = 5.8$, and thus are important for earthquake engineering studies. The moment calculated by Fourier analysis of surface waves agrees with the moment estimated from field measurements of fault offset. The earthquake engineering significance of the complex pattern of energy release is discussed. — *from* Authors' abstract

03302 **Tsai, N. C.** A note on the steady-state response of an elastic half-space: Seismol. Soc. America Bull., v. 60, no. 3, p. 795-808, illus., table, 1970.

With reference to the influence of local geology on earthquake ground motions, a more complete analytical formulation is made of the well-known problem of a horizontally stratified, linearly-elastic half-space subjected to vertically traveling, sinusoidal, plane waves. A more general interpretation of a result of Kanai is given,

and a recursion formula is derived for computing amplification spectra. Some special properties of the system are pointed out and numerical examples are given. — Author's abstract

03396 **Tschanz, C. M.; Pampeyan, E. H.** Geology and mineral deposits of Lincoln County, Nevada: Nevada Bur. Mines Bull. 73, 187 p., illus., tables, geol. maps, 1970.

Precambrian outcrops are igneous and metamorphic in the southeast, and the clastic Johnnie Formation in the southwest; Paleozoic strata thin eastward to abruptly pinch out at a hinge line where marginal facies more like Colorado Plateau rocks are overlain by Triassic rocks. Local uplifts occurred late in four upper Paleozoic periods; Mesozoic sediments were eroded during an orogeny culminated in great thrust faults; thick Tertiary volcanics poured over one third of the county, followed by basin-range faulting and Pliocene lake beds and tuffs. Cenozoic sediments cover a third of the area. Buried and complex structure is described by ranges and mining districts. Mineral production is mostly from Cambrian rocks. Ore deposits are hydrothermal, related to regional thrust faults and prevolcanic intrusives; most productive are mesothermal bedded replacement base metals, epithermal gold-silver veins, and pyrosomatic tungsten. — GDC

03070 **Tullis, Jan.** Quartz—Preferred orientation in rocks produced by Dauphiné twinning: Science, v. 168, no. 3937, p. 1342-1344, illus., 1970.

X-ray analyses of quartz aggregates deformed in the laboratory and in nature show a striking difference in the preferred orientation of the positive and negative trigonal forms. These observations may be accounted for by mechanically induced Dauphiné twinning. This orienting mechanism is unusual in that it requires no permanent strain. — Author's abstract

Turcotte, D. L. *See* Schubert, Gerald. 03420

Turekian, K. K. *See* Walker, J. C. G. 03223

Turekian, K. K. *See* Bertine, K. K. 03641

Turnbull, J. MacNeil. *See* Edge, Duane E. 03225

03370 **Turnbull, William D.** Mammalian masticatory apparatus: Fieldiana — Geology, v. 18, no. 2, p. 149-356, illus., tables, 1970.

Soft parts, rare in fossil materials, do leave distinct impressions on adjacent bone elements. Little noticed have been those osteological features related to jaw musculature which is uniquely related also to tooth wear and dental morphology. Detailed documentation of the masticatory apparatus, including relationship of musculature to skeleton, is presented, with interpretation of mechanics and evolution, for nine selected Recent mammals — two close to stem line forms in a generalized group, the others in three specialized adaptive groups: carnivore-shear, ungulate-grinding, and rodent-gnawing types. Implementing the basic apparatus, jaw musculature comprises three jaw-closing muscle groups (masseter, temporalis, and pterygoideus) and a single jaw-opening, digastric group. In addition are incisor and premolar areas, and the glenoid-condyle joint, or fulcrum. — GDC

Uhlmann, D. R. *See* Scherer, G. 03291

03342 **Ulbrich, Mabel C.** Chemical individuality of lunar, meteoritic, and terrestrial silicate rocks: Science, v. 168, no. 3937, p. 1375-1376, illus., 1970.

The potentiality of a suggestion offered by Turner and Ulbrich (1969) as to a basis for chemical comparison of nonterrestrial with terrestrial rocks is illustrated by presenting some composition fields plotted for igneous rocks, eucrite meteorites, and surface lunar materials. In the field of terrestrial rocks high values of Ca/Na are invariably associated with low values of Fe/Mg; in that of lunar rocks and eucrites both are consistently high. Plots of other chemical parameters likewise reveal consistent

chemical differences between terrestrial and nonterrestrial rocks, and also between lunar rocks so far sampled and eucrites. Collectively the chemical data preclude identification of lunar and meteoritic rocks with familiar terrestrial types such as basalt and gabbro which they resemble texturally and to some degree mineralogically. — DBV

03100 **Uluğür, Mustafa Elmas.** Fluvial physiography as a factor in basin response [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4612B, 1970.

03371 **Updike, R. G.; Péwé, T. L.** A new Quaternary formation in northern Arizona: Plateau, v. 43, no. 1, p. 21-26, illus., 1970.

The Sinagua Formation, a sedimentary deposit covering several tens of square kilometers about the lower slopes and perimeter of San Francisco Peaks in northern Arizona, consists of eight major fan-shaped deposits radiating from the peaks, each coalescing laterally with other fans or terminating against lava flows. From field relations, the age of the Sinagua is between 530,000 ± 125,000 yr and 2.7 ± 1.0 m.y., and therefore is early to middle Pleistocene; deposition may have involved a long period of late Cenozoic time. Further study may indicate a close relation to either volcanic activity (lahars) or to pluvial periods during early and middle Pleistocene. Similar deposits have been described in mountainous areas elsewhere in western United States, but origin as well as age have remained in question. The Sinagua may provide a key to better understanding and solution of these questions. — MCM

03700 **U.S. Coast and Geodetic Survey.** (compiler). Magnetic variation (6th edition), epoch 1970.0 — H.O. 1706: Washington, D.C., U.S. Naval Oceanog. Office, scale 1:39,000,000, 1970.

03209 **U.S. Geological Survey.** Aeromagnetic map of the Lynn quadrangle, Essex and Suffolk Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-709, scale 1:24,000, 1970.

03187 **Valastro, S., Jr.; Davis, E. Mott.** University of Texas at Austin radiocarbon dates VIII: Radiocarbon, v. 12, no. 2, p. 617-639, table, 1970.

03346 **Valentine, James W.; Lipps, Jere H.** Marine fossils at Rancho LaBrea: Science, v. 169, no. 3942, p. 277-278, illus., 1970.

Marine assemblages of foraminifera, ostracods, mollusks, and echinoids were recovered from deposits stratigraphically beneath the classic vertebrate assemblages from the tar pits at Rancho LaBrea. The marine fossils indicate deposition in quiet, shallow water and suggest that accumulation of the type Rancholabrean material began during Wisconsin time. — Authors' abstract

Vali, V. *See* Slade, D. V. 03088

03527 **Vallee, Marcel; Dubuc, Fernand.** The St. Honore carbonatite complex, Dubuc County, Que. [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 299, 1970.

VanDyke, L. H. *See* Swann, D. H. 03059

VanLandingham, Sam L. *See* Messina-Allen, S. 03585

Vemuri, Narasimhamurty. *See* Vemuri, Venkateswararao. 03547

03547 **Vemuri, Venkateswararao; Vemuri, Narasimhamurty.** On the systems approach in hydrology: Internat. Assoc. Sci. Hydrology Bull., v. 15, no. 2, p. 17-38, illus., 1970.

There is a long felt need for a general theoretic frame work for hydrologic systems research which imbeds dynamical, structural, spatial and behavioral aspects of modeling with predictive powers. Many of these problems can be effectively studied by systems analysis. The process of system modeling for large-scale, nonlinear, time-lag systems can be rationalized by suitably identifying and modeling subsystems.

When computers are used as modeling tools methods of formulating the problem, choice of the computer used, and choice of performance criteria greatly influence the results. This in turn imposes certain limits on the validity of computer simulated models. These aspects are discussed by studying the nature of hydrologic systems and the nature of the associated inverse problems and requirements for validating the models. — Authors' abstract

Vergano, P. J. *See* Scherer, G. 03291

03684 **Verma, Rameshwar D.; Brutsaert, Wilfried.** Unconfined aquifer seepage by capillary flow theory: Am. Soc. Civil Engineers Proc., v. 96, paper 7363, Jour. Hydraulics Div., no. HY 6, p. 1331-1344, illus., 1970.

A numerical scheme is presented to analyze a two-dimensional unconfined aquifer of rectangular cross section to determine the fall of water table, the water content, and the rate of outflow into an adjoining water body which fully penetrates the aquifer. The capillary or unsaturated flow above the water table is considered through use of Richards' equation. It was found that the problem can be solved by an alternating explicit-implicit finite difference scheme. It has the advantage of being efficient and of being suitable even when the fully saturated flow zone is very small. The unknown position of the seepage surface and the unknown boundary between the saturated and the unsaturated zone constitute a very critical aspect of the calculations. — ASCE abstract

Vigier, Gaston. *See* Londe, Pierre. 03631

03175 **Virgo, David; Hafner, Stefan S.** Fe^{2+},Mg order-disorder in natural orthopyroxenes: Am. Mineralogist, v. 55, nos. 1-2, p. 201-223, illus., tables, 1970.

The Fe^{2+}, Mg distribution over the M1 and M2 sites in orthopyroxenes from 30 granulites, 2 rocks from the Stillwater complex, and 5 volcanic rocks has been measured. The distribution is described using the disordering parameter p, where $p = X_1(1-X_2)/X_2(1-X_1)$, and X_1, X_2 are the atomic fractions $Fe^{2+}/(Fe^{2+}+Mg)$ at M1 and M2, respectively. The data are interpreted in terms of the previously reported heating experiments on natural crystals in the range 500-1,000°C. Where X is less than 0.6, the Fe^{2+}, Mg distribution is close to ideal at each site. In the granulites and plutonic rocks, p is about 0.028, and this corresponds to an equilibrium distribution temperature of about 480°C. Volcanic orthopyroxenes generally are more disordered and have p-values equivalent to temperatures of about 500-600°C. In crystals with X greater than 0.6 the distribution is far from ideal. — *from* Authors' abstract

03670 **Vogt, P. R.; Anderson, C. N.; Bracey, D. R.; Schneider, E. D.** North Atlantic magnetic smooth zones: Jour. Geophys. Research, v. 75, no. 20, p. 3955-3968, illus., 1970.

Model studies show that the low anomaly amplitudes in the 400-km-wide magnetic smooth zones bordering the North Atlantic can be explained by sea-floor spreading during the Early Triassic. The 100-km-wide transition between the low-amplitude zones and correlatable 200-γ anomalies toward the ridge crest can be explained in terms of rapid polar wandering (25 cm per yr) and simultaneous sea-floor spreading of 1 cm per yr. An alternate theory for the smooth zone has the low anomaly amplitudes created by the Tertiary arctic extension of the Mid-Atlantic Ridge; while the rift is still close to terrestrial sediment sources, new sea floor is kept inundated by sediment, which enters the rift valley through transverse fracture valleys. In place of pillow basalts, less magnetic dolerite sills are formed at the basement-sediment interface. Any magnetized pillows buried by sediment may be heated while still in the axial zone. — DBV

03427 **Vokes, Emily H.** Notes on the fauna of the Chipola Formation — [Pt.] 2, *Chicoreus* (*Siratus*) *juliagardnerae*, new name for *Murex gardnerae* Vokes *non* Dall, with observations on the species: Tulane Studies Geology and Paleontology, v. 8, no. 1, p. 51-52, 1970.

A new name is proposed for a species from the early Miocene Chipola Formation in Florida, which was originally named *Murex* (*Murex*) *gardneri* E. H. Vokes, 1963 from a large specimen figured by Gardner, 1947 as *M. chipolanus* Dall, and was later assigned to *Chicoreus* (*Siratus*) by Vokes (1965). Later, Vokes (1967) assigned *Murex trophoniformis* to *Chicoreus* (*Phyllonotus*) and showed it to be a synonym of the earlier named *Alectrion gardneri* Dall, 1915. Thus the new name is proposed to avoid secondary homonymy. *C. juliagardnerae* is most abundant in the basal Chipola beds, diminishing in the upper beds; *C.* (*Siratus*) *chipolanus* is abundant in both lower and upper beds, apparently being more adaptable to changes in sediment ecology. — VMJ

03431 **Vokes, Emily H.** Notes on the fauna of the Chipola Formation — Pt. 3, Two new species of *Vasum* (Mollusca: Gastropoda), with comments on *Vasum haitense* (Sowerby): Tulane Studies Geology and Paleontology, v. 8, no. 2, p. 88-92, illus., 1970.

Two new species based on very well preserved specimens are described from the early Miocene Chipola Formation at the classic Ten Mile Creek locality, Calhoun County, Fla. *V. tribulosum* n.sp. is clearly ancestral to the *V. muricatum* line and probably also to the *V.* (*Hystrivasum*) line. *V. elongatum* n.sp. is of the *V. capitellum* line, and bears a strong but coincidental resemblance to a *Polygona*. Of the two species already known from the Chipola (E. H. Vokes, 1966), no new material of *V. chipolensis* has been found, but new large specimens of *V. haitense* (Sowerby) suggest that a specimen from the Tampa Limestone figured by Dall (1915) as *V. engonatum*, and synonymized with *V. haitense* by Vokes (1966), is in fact a new species, as yet unnamed. — VMJ

03524 **Vokes, Emily H.** Cenozoic Muricidae of the western Atlantic region — Pt. 5, *Pterynotus* and *Poirieria*: Tulane Studies Geology and Paleontology, v. 8, no. 1, p. 1-50, illus., 1970.

This paper treats systematically the two most ancient, closely related muricine genera: *Pterynotus*, with subgenera *Pterochelus*, *Purpurellus*; *Poirieria*, with subgenera *Paziella*, *Flexopteron*, *Panamurex*, *Pazinotus* n.subgen. (type species *Eupleura stimpsonii*). A total of 42 species are described including 10 new and four renamed homonyms; of the total, 12 are assigned to *Pterynotus* s.s., 7 to *Paziella*, 15 to *Panamurex*. First New World occurrences are: *Pterynotus*, *Paziella*, Paleocene of Alabama; *Poirieria* s.s., lower Eocene of Alabama; *Pterochelus*, *Panamurex*, Oligocene of Mississippi; *Pazinotus*, *Flexopteron*, upper Miocene of Jamaica — all have at least one living species in the western Atlantic, except *Flexopteron* which is extinct; *Purpurellus*, lower Miocene of North Carolina — living only off west coasts of Africa and tropical America. — VMJ

03525 **Vokes, Emily H.** *Hexaplex* (*Hexaplex*) *engonatus* (Conrad) — Errata and corrigenda [to "Cenozoic Muricidae of the western Atlantic region," Pt. 4, 1968]: Tulane Studies Geology and Paleontology, v. 8, no. 1, p. 51, 1970.

The original reference for this species (ibid., v. 6, no. 3, p. 85-126, 1968) should read: "*Murex engonatus* Conrad, 1833, Fossil Shells Tertiary Formations North Amer., v. 1, no. 3, p. 30." Regarding the same species, Vokes stated that, although the type locality was said to be Claiborne Bluff, Ala., no specimens had ever been taken from the Gosport Sand; H. B. Stenzel points out that the type specimen probably came from the Lisbon Formation, middle Eocene, at the base of that section. — VMJ

VonGonten, W. D. *See* Osoba, J. S. 03520

vonSury, H. *See* Federer, B. 03644

vonThüna, P. C. *See* Aronson, J. R. 03695

Vormeringer, Raymond. *See* Londe, Pierre. 03631

Vos, M. A. *See* Hewitt, D. F. 03455

03206 **Vredenburgh, L. D.; Cheney, E. S.** Sulfur isotopic fractionation accompanying maturation of Paleozoic petroleum, Wind River Basin, Wyoming, a synopsis: Mtn. Geologist, v. 7, no. 2, p. 83-87, illus., 1970.

This detailed study conclusively demonstrates that sulfur isotopic fractionation can occur during maturation of petroleum. Pennsylvanian and Permian crude oils of the Wind River Basin increase in δS-34 from -7 permil in the shallow high-sulfur crudes to +7 permil for the low-sulfur crudes at depths of 12,000 feet. Hydrogen sulfide associated with the Paleozoic oils has a range of 15 permil. Instead of a concomitant enrichment in S-32, as the associated petroleums become isotopically heavier, the hydrogen sulfide increases to 10 permil at depths of 12,000 feet. Formation water sulfate at shallow depths is 15 to 30 permil, but is 11 to 15 permil at depths of 12,000 feet. Hydrogen sulfide apparently has a dual origin: (1) inorganic, thermal desulfurization of crude oils below some threshold depth, and (2) bacterial reduction of sulfate in shallow-formation waters. — Authors' abstract

03340 **Wagener, H. D.** Geology of the southern two-thirds of the Winnsboro 15-minute quadrangle, South Carolina: South Carolina Div. Geology Map Ser. MS-17, scale about 1 in. to 1 mi., separate text, 1970.

Greenschist facies Carolina Slate Belt lithologies underlie the southeastern section; all other metamorphic rocks are Charlotte Belt types of almandine amphibolite facies. Numerous intrusions and a large pluton dominate the west-central portion; sillimanite-grade rocks occur around the northern and western borders of the plutonic complex. Structures involving metamorphic rocks are highly complex. History is as follows: deposition of sedimentary rocks and extrusion of mafic volcanic rocks (Paleozoic); deep burial; deformation producing faults and folds; high-rank metamorphism (Pennsylvanian-Permian); intrusion of a large pluton; emplacement of dikes; and post-metamorphic (Mesozoic,) intrusion of diabasic dikes and gabbro. Exploited mineral resources are: water, granite, and saprolite for road metal. — *from* Author's abstract

Wainerdi, R. E. *See* Hoffman, B. W. 03564

Wainwright, J. E. N. *See* Starkey, J. 03555

03732 **Walcott, R. I.** Flexural rigidity, thickness, and viscosity of the lithosphere: Jour. Geophys. Research, v. 75, no. 20, p. 3941-3954, illus., tables, 1970.

The Earth's lithosphere and asthenosphere are modeled as a thin elastic sheet and a fluid substratum, respectively. The flexural rigidity of the lithosphere is deduced from observations of wavelength and amplitude of bending in the vicinity of supercrustal loads. Values are found for the Basin and Range Province, Caribou Mts. of northern Alberta, Boothia uplift in Arctic Canada, beaches of Pleistocene Lakes Agassiz and Algonquin, and Hawaii and near island arcs. For short-term loads flexural rigidity of the continental lithosphere is about two orders of magnitude larger than for long-term loads, indicating nonelastic behavior of the lithosphere with viscous and elastic response to stress. Thickness of the continental lithosphere is inferred to be about 75 km or more. The anomalously low flexural rigidity of the Basin and Range province may be due to a very thin lithosphere (about 20 km) underlain by a hot lower crust. — DBV

03746 **Walker, D. A.; Buckley, D. E.** Some techniques and applications of scanning electron microscopy in the fields of marine science: Maritime Sediments, v. 5, no. 3, p. 113-118, illus., 1969 [1970].

Many specialized research disciplines of marine science involve minute particles or organisms, whose nature and detailed structure are often the key to important oceanic processes or environments. Considerable effort is made to obtain data on size, shape, and ultrastructure of such materials as testate foraminifera (Protozoa), clay minerals, organic-rich aggregate particles, and crystals of minerals precipitated on the sea floor. The scanning electron microscope can be used to obtain images of materials having features in the micron and submicron size range. This paper describes some techniques for sample preparation and mounting, with specific appli-

cations tested at the Atlantic Oceanographic Laboratory, Bedford Institute, Nova Scotia, for biological, micropaleontological, and mineralogical studies, and various methods of size analysis. — GDC

03223 **Walker, J. C. G.; Turekian, K. K.; Hunten, D. M.** An estimate of the present-day deep mantle degassing rate from data on the atmosphere of Venus: Jour. Geophys. Research, v. 75, no. 18, p. 3558-3561, table, 1970.

We argue that the present rate of escape of hydrogen from the upper atmosphere of Venus establishes an upper limit for the rate of degassing of water from the interior of the planet. This upper limit is 2.4×10^9 grams of water per year. If we assume that this value holds also for deep-mantle degassing from the Earth, we find that the rate is insufficient, by five orders of magnitude, to supply the water at the Earth's surface in 4.5×10^9 years. An early episode of greatly enhanced degassing appears to be required. — Authors' abstract

03743 **Walker, Laurence G.** Physical stratigraphy of the Ordovician Martinsburg Formation and its lateral equivalents in southwestern Virginia: Southeastern Geology, v. 11, no. 4, p. 215-229, illus., 1970.

The Ordovician Martinsburg Formation in southwestern Virginia is a shallow-water geosynclinal unit consisting of three lithofacies. A lower limy facies of limestone and calcareous siltstone occupies the western and central outcrop belts of the Valley and Ridge province, replaced to the east and vertically by a silty facies of siltstone and shale. The upper sandy facies consists mostly of sandstone and siltstone and underlies littoral and nonmarine redbeds of the Juniata Formation. The Martinsburg sediments were deposited in a shallow marine environment with a diverse benthonic fauna. The change from a carbonate depositional environment to nonmarine conditions occurred during Middle (Trentonian) to Late (Maysvillian) Ordovician time as terrigenous material spread southwestward across the southern Appalachian geosyncline. The source area was produced by Taconic orogenic activity that culminated in nonmarine conditions in the geosyncline. — *from* Author's abstract

03058 **Walker, William R.; Stewart, Ronald C.** Deep-well disposal of wastes — Closure [to 1969 discussion of paper 6171, 1968]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Sanitary Eng. Div., no. SA2, p. 610, 1970.

Walker and Stewart reply to R. D. Sadow's discussion (ibid., v. 95, no. SA5, p. 966-967, 1969) of paper 6171 (ibid., v. 94, no. SA5, p. 945-968, 1968); *see* Abstracts of North American Geology, May 1970 and April 1969.

03639 **Wallace, D. E.; Spangler, D. P.** Estimating storage capacity in deep alluvium by gravity-seismic methods [with French abs.]: Internat. Assoc. Sci. Hydrology Bull., v. 15, no. 2, p. 91-104, illus., tables, 1970.

Large volumes of ground water are contained in the deep intermontane valleys of Basin and Range regions. Determining the shape and storage capacity of these basins by drilling can be expensive and difficult, but can often be done by combining gravimetric and seismic refraction interpretations. Basin boundaries are determined by gravimetric methods, with bulk density samples taken of all representative formations. Density values can then be correlated with seismic velocities to estimate subsurface porosities. Studies indicate that seismic velocity varies inversely with porosity for alluvial deposits. These values can be correlated with their respective formations in the basin from geologic sections derived from the seismic refraction survey. Thus, with volume and porosity of the alluvium known, storage capacity (both present and potential) can be computed. — *from* Authors' abstract

03423 **Wallick, Edward I.; Knauer, George A.** A modification of the benzene synthesis method for tritium analysis: Water Resources Research, v. 6, no. 3, p. 986-988, illus., tables, 1970.

A modification of the benzene synthesis method for tritium analysis by liquid scintillation counting is suitable for limited production of hydrologic samples and has a

lower detection limit of 10 TU (1 TU = 10^{-18} T/H). Procedures are described for elimination of sulfide quenching of the benzene and optimization of the acetylene-benzene conversion. Tritium isotopic fractionation is constant during benzene synthesis with a loss of (19.3 ± 0.2) percent of the water sample tritium activity. Cross checks with other laboratories agree within counting statistical error. — Authors' abstract

03728 **Wang, Chi-Yuen.** Density and constitution of the mantle: Jour. Geophys. Research, v. 75, no. 17, p. 3264-3284, illus., tables, 1970.

An empirical relation between bulk sound velocity and density is applied to the prediction of density distribution in the mantle to a depth of 1000 km. In the lower mantle and core, density changes are computed using the Adams-Williamson relation. A model that satisfies relevant geophysical data (including the periods of Earth's free oscillations, Rayleigh and Love wave phase and group velocities along great-circle paths, and the total mass and moment of inertia of the Earth) well within the observational uncertainties has a density in the upper 170 km of the mantle of about 3.3 g per cm^3; this density distribution supports the idea that the upper mantle is composed of peridotite. Mean atomic weight for the lower mantle is about 21.3-21.5, suggesting that the entire mantle may have a uniform iron content. — DBV

Wanless, R. K. *See* Boyle, R. W. 03478

Ward, William C. *See* Wilson, James Lee. 03607

03682 **Ward, William C.; Folk, Robert L.; Wilson, James Lee.** Blackening of eolianite and caliche adjacent to saline lakes, Isla Mujeres, Quintana Roo, Mexico: Jour. Sed. Petrology, v. 40, no. 2, p. 548-555, illus., 1970.

Dark colored constituents of rubble gravel are (1) blackened Pleistocene (?) eolianite country rock and (2) black porous laminated "caliche-algal micrite" crusts. Brown fragments, 50 to 75 percent of the rubble, are fragments of caliche and eolianite. The blackened calcarenite is infiltrated with finely disseminated organic matter of algal origin. Most of the black is organic, but some may be FeS. The caliche was formed simultaneously with algal production. The pH was probably high enough and the Eh low enough for the preservation of the organic material, and in such a reducing environment associated with sulfate deposition in the lakes, bacterial action could produce H_2S. Black fragments in limestone strata, then, may be an aid in locating coastal areas in ancient carbonate provinces and the landward edge of evaporite deposits. — HRC

03141 **Wasson, B. E.; Thomson, F. H.** Water resources of Lee County, Mississippi: U.S. Geol. Survey Water-Supply Paper 1899-B, p. B1-B63, illus., tables, 1970.

Lee County has sufficient water-supply potential to meet foreseeable needs; wisely managed, the resources can support further economic growth. Water use in the Tupelo area, about 7 mgd in 1967, was supplied by withdrawals from the two major aquifers, the Eutaw and Gordo Formations. In recent years water levels have declined 3-5 feet annually in this heavy withdrawal area; doubled withdrawal is possible, but would result in loss of artesian conditions. In the northeastern section, additional recharge to the Coffee Sand could be induced by constructing reservoirs in the outcrop area. Transfer of water from the Coffee Sand to the underlying Eutaw Formation is already occurring through the many open-hole wells. The feasibility of constructing recharge wells in the Eutaw and Gordo aquifers near Tupelo should be investigated. Quality of water in streams and aquifers is generally good. — *from* Authors' abstract

03357 **Watson, T. H.** A note on fast computation of Rayleigh wave dispersion in the multilayered elastic half-space: Seismol. Soc. America Bull., v. 60, no. 1, p. 161-166, 1970.

Matrix formulas for modal solutions in the layered, elastic half-space are modified to give faster machine computation. Accuracy at high frequencies is also included.

Computing time is reduced by 30 percent from the fastest program previously reported. — Author's abstract

03668 **Watts, W. A.** The full-glacial vegetation of northwestern Georgia: Ecology, v. 51, no. 1, p. 17-33, illus., tables, 1970.

Pollen diagrams and seed diagrams are presented for sediments from two small sinkhole ponds in Bartow County, Ga. Colluvial deposits < 150 cm thick, with moderately to poorly preserved plant fossils, are underlain by 250-400 cm of copropelic clays, which yield C-14 dates of 20,100 and 22,900 yr B.P. near the base, indicating Wisconsin age. The full-glacial sediments are rich in well-preserved pollen and plant macrofossils; the pollen assemblage, dominated by pine, with small amounts of spruce, oak, hornbeam, and herbs, closely resembles assemblages from southeastern North Carolina. Jack-pine and spruce needles and a rich macroflora of aquatics show close relationship with modern flora of northern New England. In the postglacial pollen assemblage, an early oak-dominated phase is followed by a pine-dominated phase, with coastal plain disjunct swamp species, which lasts to the present. — VMJ

03742 **Wayman, R. A.; Collings, R. K.; Buchanan, R. M.** Some unusual aspects of Canadian industrial minerals [abs.]: Mining Eng., v. 22, no. 1, p. 42, 1970.

03158 **Weaver, P. F.; Yuen, P. C.; Prolss, G. W.; Furumoto, A. S.** Acoustic coupling into the ionosphere from seismic waves of the earthquake at Kurile Islands on August 11, 1969: Nature, v. 226, no. 5252, p. 1239-1241, illus., 1970.

A second example of the disturbance of the ionosphere by an earthquake has been documented at the University of Hawaii after the August 11, 1969, Kurile Islands earthquake. While propagating along the surface of the Earth toward Honolulu, the Rayleigh waves launched acoustic pressure waves which traveled almost vertically upward into the atmosphere. The displacements associated with the pressure waves increased as density decreased, so that displacements of the order of millimeters on the surface grew into displacements of the order of kilometers at ionospheric heights. Thus Doppler records, which monitor the contours of constant electron density, have shape similar to seismic records of Rayleigh wave surface motion. — DBV

03333 **Webb, H. W.; Nunan, W. E.; Penley, H. M.** Road log — Storm-damaged areas in central Virginia: Virginia Minerals, v. 16, no. 1, p. 1-10, illus., 1970.

The road log was prepared to point out and record some of the damage due to the torrential rains of Hurricane Camille in Nelson, Rockbridge, and Augusta Counties in August 1969. In addition to flood damage, landslides of the debris-avalanche type carried soil, boulders, and trees down mountain slopes. Siltation, channel scour, and deposition of debris occurred in river and creek valleys. — ESL

Webb, Wayne E. *See* Weigle, James M. 03584

Wechter, M. *See* Laul, J. C. 03651

Weiblen, Paul. *See* Green, John. 03581

03329 **Weidler, Jay B., Jr.; Paslay, Paul R.** Constitutive relations for inelastic granular medium: Am. Soc. Civil Engineers Proc., v. 96, paper 7475, Jour. Eng. Mechanics Div., no. EM 4, p. 395-406, illus., 1970.

The results of an experimental and analytical program to develop stress-strain relations for a granular medium are presented. Explicit three-dimensional relations are given which represent the inelastic deformation of the medium. A simple version of the formulation is used to represent experimental results for a locally quarried quartz, and an evaluation of the relation is presented. The simplified relations are seen to be a compromise between mathematical tractability on the one hand and accuracy of prediction on the other. — ASCE abstract

03584 **Weigle, James M.; Webb, Wayne E.** Southern Maryland records of six selected wells, water levels, and chemical analyses of water: Maryland Geol. Survey Basic Data Rept. 4, 48 p., illus., tables, 1970.

The area investigated includes Calvert, Charles, and St. Marys Counties, where drainage is to the Potomac and Patuxent Rivers and Chesapeake Bay; some data from Anne Arundel and Prince Georges Counties are included. Data include records of about 424 wells and test holes, chemical analyses of water from 150 wells and 13 stream sites, and hydrographs based on periodic measurements of water levels in 17 wells. A table shows geologic units and their geohydrologic characteristics; maps show locations of wells, test holes, and water-sampling sites in Calvert and St. Marys Counties and for southern Maryland sites not shown on the county maps. — MCM

Weinaug, Charles F. *See* Green, Don W. 03073

Weiner, Catherine. *See* Greenfield, Leonard J. 03052

03542 **Weiss, Malcolm P.** Oncolites forming on snails (*Goniobasis*): Jour. Paleontology, v. 44, no. 4, p. 765-769, illus., 1970.

Thick crusts or coatings of calcareous algal laminite are not mortal to snails of the genus *Goniobasis* (nor, probably, other snails), for the snails restrict them to the exterior of the spires. Among oncolites with nuclei of snail shells, those with more laminae on the spire than about the aperture started forming before the death of the snail; others started and formed after the death of the host. [Formation of Paleocene and Eocene oncolites in snail shells in streams and lakes of Utah are interpreted in the light of observations on living *G. tenera* in a stream in Meade County, Ky.] — Author's abstract

03218 **Wells, Steve; Wilson, Ted.** Parker's Pit Cave (challenge in 3 dimensions): Natl. Speleol. Soc. NSS News, v. 28, no. 7, p. 94-97, illus., 1970.

Recent explorations in Parker's Pit Cave, near Borden's Pit Cave in northwestern Harrison County, Ind., have revealed a complex cave system with canyon-like passages and pits reaching a depth of 230 feet below the entrance, making it the deepest known cave in Indiana. A 5,171-feet stretch of the cave was mapped between November 1969 and March 1970. The cave is on Crawford Upland, an area of maturely-dissected hills capped by Chester clastics and thin limestone. Cavern development is in the Paoli and Ste. Genevieve limestones which are 200-feet thick in the area. Lower cave levels may reach the St. Louis limestone which underlies the Ste. Genevieve. No major stream has been found in the cave. It is possible that a connection will be found between Parker's Pit Cave and Borden's Pit Cave in the future. — EH

03576 **Wesson, Robert L.** A time integration method for computation of the intensities of seismic rays: Seismol. Soc. America Bull., v. 60, no. 2, p. 307-316, illus., tables, 1970.

A finite-difference time integration method for the calculation of seismic ray intensity is developed. Discontinuities in the depth derivatives of the velocity-depth function at layer boundaries cause anomalies in the intensity distance curves calculated using the standard integral formulation. The time integration method overcomes these difficulties. Calculations for a simple analytic case and a Gutenberg earth model demonstrate the difficulties with the standard integral method and the superior performance of the time integration scheme. The method may also be applied to laterally inhomogeneous earth models. — Author's abstract

West, P. J. *See* Housner, G. W. 03031

Wetherill, G. W. *See* Gopalan, K. 03696

03021 **Wheeler, J. O.** Summary and discussion, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 155-166, illus., 1970.

The summary, based mainly on the foregoing papers in this volume, outlines the geometry of a structure section across the southern Canadian Cordillera. The Cordillera consists essentially of two severely deformed fold belts, separated by the less deformed Intermontane Zone. The Eastern Cordilleran Fold Belt, or Eastern Fold Belt, resembles an alpine orogen, with the Eastern Core Zone (Columbia Mts.) containing recumbently folded high-grade metamorphic rocks, and a Marginal Zone (Rocky Mts.) with a northeastward-directed surficial deformation. The Cascade segment of the Western Fold Belt has easterly and westerly-spreading thrust faults that root near a metamorphic core. Ultramafic rocks are associated with the thrusts. The Intermontane Zone has remained relatively stable since Jurassic time except for repeated jostling along faults, Tertiary volcanism and local continental sedimentation. — *from* Author's abstract

03272 **Wheeler, J. O.** (editor). Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, 166 p., illus., tables, geol. maps, 1970.

This paper is a progress report on the Southern Cordillera Structure Project, sponsored by the National Advisory Committee on Research in the Geological Sciences. Most of the succeeding 13 papers were presented at the annual meeting of the Geological Association of Canada at Vancouver, British Columbia, in April, 1968. The introduction outlines the history and background of the project and provides the regional setting for the succeeding papers, summary and discussion which range from the structure and evolutionary syntheses of large areas to detailed accounts of the structure and development of small areas. The zone of investigation deals with areas across the southern Canadian Cordillera, progressing westward from the Rocky Mountains to the Cascade Mountains. — EH

Wheeler, J. O. *See* McTaggart, K. C. 03273

03274 **Wheeler, J. O.** Introduction, *in* Structure of the southern Canadian Cordillera: Geol. Assoc. Canada Spec. Paper 6, p. 1-5, illus., 1970.

The Southern Cordillera Structure Project was designed to obtain a structure section across the southern Cordillera of British Columbia, extending from the lower Fraser Valley northeastward past Kamloops and through the Rocky Mountains via Bow Valley. The first field studies were begun in 1964. Twenty geologists have participated, supported by grants from the Geological Survey of Canada and the National Research Council, with the Geological Survey and the British Columbia Department of Mines and Petroleum Resources also participating directly. A brief summary is given here on the major tectonic and structural elements of the Canadian Cordillera. — EH

03476 **Wheeler, J. O.** The Western Cordillera, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 693, p. 37-44, 1970.

The western Cordillera is dominated by two fold belts of opposing asymmetry — the eastern of Proterozoic and lower Paleozoic sedimentary rocks, and the western of upper Paleozoic and Mesozoic volcanic rocks. It is one of the world's great natural laboratories and development of man's environment in the area requires application of earth science; the area yields metals and minerals, but few fuels. Earth science has contributed greatly to economic and social development, and will contribute even more in the future. The history of research in the area is reviewed, and significant advances and particular contributions to the geology discussed; a summary of the present level of activity is given. Areas where activity needs to be increased include metallogenic studies, geophysics, Quaternary research, and special problems. Nine recommendations for future research are given. — ESL

White, Joe L. *See* Low, Philip F. 03123

03573 **Whitesides, D. V.** Common errors in developing a ground-water aquifer: Ground Water, v. 8, no. 4, p. 25-28, illus., 1970.

This paper presents some of the more common errors made in development of ground-water supplies in alluvial aquifers along the Ohio River in Kentucky. Ample available literature on proper methods of development of the alluvial aquifers generally seems to have been ignored by water users in the area. More common errors include treating the aquifer as an inexhaustible underground river. Wells generally are clustered in small areas remote from the river, and are likely to be located more for convenience and economy of pipeline or property access than for hydrologic considerations. It is hoped by highlighting these errors and showing alternative methods of development that proper practices will be fostered. Stages in the development of two hypothetical ground-water aquifers in the valley are shown by illustrations stressing common errors made and alternative methods of development, taking into account hydrologic considerations. — *from* Author's abstract

03458 **Whitmore, D. R. E.** Metallogeny and characteristics of sulphide deposits of the Precambrian of Canada [abs.]: Canadian Mining and Metall. Bull., v. 63, no. 695, p. 287, 1970.

03101 **Whitney, Harold Tichenor, Jr.** Plastic movement of soft clay in a sheeted excavation [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4612B-4613B, 1970.

Whitney, J. A. *See* Hamilton, E. L. 03725

03040 **Wiegel, Robert L.** (editor). Earthquake engineering: Englewood Cliffs, N.J., Prentice-Hall, 518 p., illus., tables, 1970.

This book is a collection of twenty papers based on lectures given during a short course in earthquake engineering at the University of California, Berkeley, primarily for practicing engineers. Papers discuss causes of earthquakes, seismic waves, faulting, strong ground motion and its measurement, structural damage by earthquakes, the 'design earthquake,' dynamic testing of models and prototype structures, soil problems and behavior, linear and nonlinear structural response, soil-pile foundation interaction, and tsunamis, as well as design of various earthquake-resistant structures. Thirteen papers are cited separately. — VSN

03446 **Wiegel, Robert L.** Tsunamis, Chap. 11 *in* Earthquake engineering (R. L. Wiegel, editor): Englewood Cliffs, N.J., Prentice-Hall, p. 253-306, illus., tables, 1970.

The term tsunami is generally used to describe the long water waves (period 5 to 60 min or longer) generated impulsively by such mechanisms as exploding islands, submerged landslides, rockfalls into bays or the ocean, tectonic displacements associated with earthquake, and underwater explosions of nuclear devices. The major cause of catastrophic tsunamis is a rapidly occurring tectonic displacement of the ocean bottom. Several examples of disastrous tsunamis and the types of damage caused by them are described, and the theory and laboratory studies of tsunami generation, travel of tsunamis in the ocean, tsunami waves along the shore (mach-reflection, diffraction, bores, etc.), distribution on run-up elevations and wave heights along a coast, tsunami distribution functions, overtopping of seawall, and tsunami wave forces are discussed with reference to numerous examples. — VSN

03719 **Wiegel, Robert L.; Noda, Edward K.; Kuba, Edward M.; Gee, Dennis M.; Tornberg, Gordon F.** Water waves generated by landslides in reservoirs: Am. Soc. Civil Engineers Proc., v. 96, paper 7279, Jour. Waterways and Harbors Div., no. WW 2, p. 307-333, illus., 1970.

Results of hydraulic laboratory tests of an idealized rockfall are presented, with the main parameters being the ratio of rockfall width to water depth, and a Froude number based upon the ratio of the average rockfall velocity to dimensionless time. For a rather large range of these two parameters, a linear theory for the generation of water waves by a similar mechanism is shown to be useful as a guide to interpreting the results. For large values of the two parameters, the linear theory is of marginal usefulness. It is shown by means of the results of two similar tests, with a geometric scale ratio of 1:4, that a small model test can be used to predict the results to be ex-

pected from a large model test even in the range where bores form, provided the velocity time histories of the falling rock are similar. — *from* Asce abstract

03429 **Wilcoxon, James A.** *Cyclococcolithina* Wilcoxon *nom. nov.* (nom. subst. pro *Cyclococcolithus* Kamptner, 1954): Tulane Studies Geology and Paleontology, v. 8, no. 2, p. 82-83, 1970.

Coccosphaera leptopora, originally described by Murray and Blackman, 1898, and placed in a then invalid genus, was designated by Hay (1966) as type species of the calcareous nannoplankton *Cyclococcolithus* Kamptner, 1954. When Kamptner erected the genus he had failed to designate a type, and had included in it *Umbilicosphaera mirabilis* Lohmann, 1902, which was already the type species of that genus. Thus the name *Cyclococcolithus* is superfluous, illegitimate, and unavailable for use under I.C.B.N. rules, and *Cyclococcolithina* is proposed to replace it. Twenty-nine species have been validly described under *Cyclococcolithus*; these are listed under the new name, each with reference to original description and figures. — VMJ

Wilkins, A. L. *See* Jongejan, A. 03296

Wilkinson, J. F. G. *See* Nash, W. P. 03161

Williams, R. E. G. *See* Shotton, F. W. 03182

03505 **Williams, Sidney A.; Millett, Frank B., Jr.** Complex silver ores from Morey, Nevada — A correction: Canadian Mineralogist, v. 10, pt. 2, p. 275-276, illus., tables, 1970.

Recomputation of the angle table for diaphorite, in a paper by S. A. Williams, ibid., v. 9, pt. 4, p. 478-484, 1968, disclosed a large number of errors; a corrected version of the table is presented here. A new approach to producing monoclinic angle tables has been devised and two advantages are discussed. — ESL

Wilmeth, R. *See* Lowdon, J. A. 03183

03051 **Wilson, Charles W., Jr.** Geologic map of the Belleville quadrangle, Tennessee: Tennessee Div. Geology Geol. Map GM 72-SE, scale 1:24,000, separate text, 1970.

The only mined mineral resource in the Belleville quadrangle is limestone, mainly from the Bigby Cannon and Carters Limestones which contain the best stone for most uses. A potential resource is chert from the Fort Payne Formation. — MCM

03568 **Wilson, H. D. Bruce.** The Superior province, *in* Geological provinces of Canada, exploration and outlook: Canadian Mining and Metall. Bull., v. 63, no. 694, p. 195-199, 1970.

Limits of the Superior province of the Canadian Shield are difficult to identify due to complex boundary relations. The province forms the core of North America and is surrounded by three provinces affected by later orogenies; it includes Proterozoic non-orogenic igneous events. Applied research and development have major roles because of valuable ferrous and nonferrous metals; the province also provides excellent opportunities for pure research. One model of the geologic history is included and draws attention to many problems for research, such as why the large east-west faulting was so late in the Archean, and the relation of ore deposits to this geologic history. The present level of activity is relatively high; much age-dating is being done, and most significant discoveries are likely to be made through Rb-Sr and U-Pb methods. Pure-science and applied science objectives are discussed; 16 recommendations are made. — ESL

03607 **Wilson, James Lee; Ward, William C.; Brady, Michael J.** Northeast Yucatan, Mexico — A new area opens for study of carbonate-evaporite sediments: Jour. Sed. Petrology, v. 40, no. 2, p. 745-749, illus., 1970.

Carbonates and evaporites being deposited in the coastal regions of northeastern Yucatan Peninsula include shallow-shelf carbonate sands and gravels, eolianites, coral reefs, carbonate mud, dolomite mud, gypsum, and salt. Recently improved roads and transportation facilities in northeastern Yucatan now make areas which merit carbonate-evaporite research reasonably accessible. In addition, this region is particularly suited for instructive field observations. — Authors' abstract

Wilson, James Lee. *See* Ward, William C. 03682

Wilson, John M. *See* Hershey, Robert E. 03065

03377 **Wilson, L. R.; Morrison, J. L.; Reid, W. E.** Development of palynological computer information at the University of Oklahoma: Oklahoma Geology Notes, v. 30, no. 4, p. 75-83, illus., table, 1970.

The objective of the palynological computer program at the University of Oklahoma is to develop an information system and place all pertinent information of Paleozoic literature in detailed data-retrieval form. The present data base covering most published Paleozoic and Mesozoic palynological literature relating to the Permian, consists of bibliographic citations; and geographic, stratigraphic, lithologic, morphologic, taxonomic, nomenclatural, floristic, and commentary materials. Problems of palynological nomenclature, taxonomy, morphology; of abundance of literature (much of it foreign); and lack of communication between laboratories can be resolved by research and evaluation of the project. The data base also contains a nearly equal amount of available geographic, stratigraphic, and lithologic information. An international standard terminology for palynology would eliminate the present reference to original published descriptions. — MCM

Wilson, Ted. *See* Wells, Steve. 03218

Wilson, William E. *See* Grossman, I. G. 03744

Wind, G. *See* Simony, P. S. 03018

03324 **Wing, R. S.** Cholame area, San Andreas Fault zone, California, a study in SLAR: Modern Geology, v. 1, no. 3, p. 173-186, illus., 1970.

The Cholame locale, between San Francisco and Los Angeles, Calif., includes a significant "San Andreas Fault Zone" segment, characterized by a gradational change in mode of tectonic adjustment, from transient creep (NW) to periodic violent movement (SE). Subordinate fold and fracture patterns on the southwest side of the fault zone have been analyzed from side-looking airborne radar imagery (AN/APQ-97 K-band), part of coverage obtained on mission flight 101 (1965) from San Francisco to San Bernadino, flown for NASA. The primary objective of this study was to investigate and document the use of SLAR imagery for geologic mapping of lineaments and to determine the level of significance of the display. The various lineaments were found to be generally enhanced to a greater degree on SLAR imagery than on low-altitude conventional aerial photography. — *from* Author's abstract

03417 **Wise, Sherwood W., Jr.** Scleractinian coral exoskeletons, surface microarchitecture and attachment scar patterns: Science, v. 169, no. 3949, p. 978-980, illus., 1970.

Scanning electron microscopic studies have revealed the configurations of the growth surfaces of scleractinian coral exoskeletons. Skeletal surfaces exhibit profuse growths of minute elongate aragonite crystals which, on basal and mural surfaces, are punctuated by scars. It is suggested that these scars are sites of attachment for the specialized processes that connect the living tissues of polyps to the nonliving skeleton. Patterns formed by the attachment scars are taxonomically significant. — Author's abstract

Witherspoon, Paul A. *See* Neuman, Shlomo P. 03076

03130 **Wobber, Frank J.** Oblique orbital photography, many advantages for regional exploration: World Mining (U.S. edition), v. 6, no. 1, p. 32, illus., 1970.

A black and white print of a color Apollo IX photo shows broad structural trends in the Appalachian Mts. near Birmingham, Alabama. Paleozoic outcrops are shown by diagonal curvilinear features, obscured to the lower left by the overlapping Cretaceous Tuscaloosa Formation. Oblique photography combined with low angles of solar illumination aids interpretation of folded and faulted zones, but greater illumination angles are best for detecting outcrop boundaries and fracture traces obscured by surficial sediments. A Gemini VI oblique black and white enlargement of a color photo over the ERG Chech area of Algeria illustrates the latter point. — ESL

03287 **Wolf, Barry.** Propagation of Love waves in layers with irregular boundaries: Pure and Appl. Geophysics, v. 78, p. 48-57, illus., 1970.

A study is made of the scattered field which results when a Love wave is incident on a layer having an irregular surface. It is shown that for the class of boundaries treated the scattered field may be described by the superposition of a finite number of Love waves. As an illustrative example the result is applied to determine the reflection from a triangular notch. — Author's summary

03734 **Wolf, Stephen C.** Coastal currents and mass transport of surface sediments over the shelf regions of Monterey Bay, California: Marine Geology, v. 8, no. 5, p. 321-336, illus., 1970.

The highest concentrations of medium and fine sands occur nearshore between 10 and 30 fms. Silt and clay accumulate at greater depths. Contours of median diameter roughly parallel the isobaths. Fine material is supplied by cliff erosion, river discharge, and reworking of Pleistocene and Recent sea-floor sediments. Seasonal changes occur in bottom currents. Irregular current flow in Monterey Canyon indicates a complex current structure with frequent shifts, and bottom topography causes local variations. Changes in current regimes are reflected in the patterns of sediment distribution and transport. The transport is chiefly parallel to the isobaths but is complex near the canyon and jetties. Longshore currents move sediments southward except near the canyon which acts as a barrier. Rip currents deposit some sediments. In the canyon, mass movement of sediments seaward is followed by deposition in channels and on the sea fan. — HRC

Wong, H. K. *See* Loring, D. H. 03707

03271 **Wong, Her Yue.** Clay petrology of the Atoka Formation, eastern Oklahoma [abs.]: Dissert. Abs. Internat., Sec. B., Sci. and Eng., v. 30, no. 11, p. 5105B-5106B, 1970.

03162 **Woodcock, A. H.; Furumoto, A. S.; Woollard, G. P.** Fossil ice in Hawaii,: Nature, v. 226, no. 5248, p. 873, illus., 1970.

Perennial ice was found late in 1969 near the summit of Mauna Kea Volcano on Hawaii. Part of the ice-lava mixture lies close to the rocky surfaces near the bases of the south walls of Goodrich Cone and Summit Cone craters. Seismic refraction indicates a minimum horizontal extent of ice of hundreds of meters and a thickness of many decameters. This ice may be the remains of known Pleistocene glaciation, which has survived near the surface in present climatic conditions because radiation effects make certain areas of the crater colder. — DBV

03381 **Woodring, W. P.** Geology and paleontology of Canal Zone and adjoining parts of Panama — Description of Tertiary mollusks (gastropods: Eulimidae, Marginellidae to Helminthoglyptidae): U.S. Geol. Survey Prof. Paper 306-D, p. 299-452, illus., 1970.

Chapter D describes 187 species and subspecies in 18 families. The Tertiary stratigraphy is reviewed and the age of the fossiliferous formations is reappraised. The name Caraba Formation is adopted for strata of late Oligocene age formerly assigned to the Caimito Formation. The Panama Formation is redefined and the age changed to late Oligocene. The Las Cascadas Agglomerate and La Boca Formation are recognized in Madden basin and the early Miocene Alhajuela Formation is defined for the youngest strata in that area. The upper Gatun Formation in the western area is of middle Miocene age, instead of late Miocene, and the Chagres Sandstone late

Miocene, instead of early Pliocene. According to radiocarbon dates, the informally named Atlantic and Pacific Muck, thought to be Pleistocene, was deposited during the postglacial rise of sea level. — *from* Author's abstract

Woods, Richard T. *See* Ahrens, Thomas J. 03363

Woollard, G. P. *See* Woodcock, A. H. 03162

03548 **Wozab, David; Jovel, J. Roberto.** Hydrological analysis of volcanic terrane, lower basin of the Rio Grande de San Miguel, El Salvador: Internat. Assoc. Sci. Hydrology Bull., v. 15, no. 2, p. 47-66, illus., tables, 1970.

Standard hydrological methods have been used to evaluate water resources of this volcanic area of about 645 sq km. The lower San Miguel Basin is a faulted valley bounded by old and recent volcanoes on the east, a tuff block to the south, and consolidated volcanics (lahars) on the west and north. The valley fill consists of pyroclastics which diminish in particle size with distance from volcanoes in the southern part, but they may be interbedded with lake deposits. To assess the feasibility of irrigating 10,000 hectares of the valley, results of the study suggest that almost half of the annual precipitation infiltrates into the ground. One third of this is accounted for by the existing balance between recharge and depletion. The remainder moves to San Miguel River as ground-water run-off; if retained, it is sufficient in quantity to meet anticipated irrigation demand. — *from* Authors' abstract

03198 **Wray, William B., Jr.** FORTRAN IV CDC 6400 computer program for constructing isometric diagrams: Kansas Geol. Survey Computer Contr. 44, 58 p., illus., 1970.

Subroutines are described to provide a method of displaying a surface in isometric pictorial representation by translating points from (x, y, z) space to (u, v) space. Options available through the parameter arrays are: diagrams can be seen from all theoretically possible viewpoints; data can be viewed in an unlimited number of rectangular subblocks; scale, line and point spacing, and density of lines and points to be plotted are variable; the vertical scale may be expanded or contracted relative to the horizontal scale without restriction; surfaces may be plotted with or without the traditional block diagram frame, and major and minor scale ticks are available; and data input is flexible. Possible applications are: N-S, E-W elevation surfaces; N-S, E-W z surfaces (thickness or percent of sand, Bouguer anomalies); x-y-z surfaces, as equilibrium surfaces in chemical stability diagrams; and x-y-f(x) surfaces, mathematical functions of two variables. — MCM

03590 **Wright, Herbert.** A teacher's guide for geologic investigations in northwestern Minnesota: [St. Paul, Minn.] Minnesota Dept. Education, 7 p., illus. [n.d.].

This guide, one of eight, combines study of topographic maps with observation in the field, and construction of cross sections. The history of glaciation and of Glacial Lake Agassiz is given, and features due to each described. The two trips described are the Crookston-Red Lake Falls area, with eight stops, and the Roseau-Karlstad area with five. — ESL

03137 **Wrigley, Robert C.** Cosmogenic radionuclides in the Lost City, Oklahoma, meteorite [abs.]: EOS, v. 51, no. 7, p. 582, 1970.

03083 **Wroblewski, E. F.** New look at a major deep drilling area, the Anadarko basin: World Oil, v. 171, no. 2, p. 29-32, illus., 1970.

Record producing wells are focusing attention on deep potential of the Anadarko basin, but unexpected dry holes also have been drilled on classic anticlinal structures that should have been productive. New information about the complex geology of the area which should reduce dry hole frequency is presented. — *from* Author's abstract

03433 **Wyckoff, Ralph W. G.** Deux espéces de chalcopyrites mises en évidence par les bactéries [Two kinds of chalcopyrites demonstrated by bacterial [oxidation]]: Soc. Française Minéralogie et Crystallographie Bull., v. 93, no. 1, p. 120-122, 1970.

Results of recent research on bacterial action on chalcopyrites are summarized. No relation was found between the purity of the chalcopyrite and its susceptibility to attack, but susceptibility may be related to the condition of formation of the chalcopyrite. Experiments using bacteria from different environments showed that some oxidize iron but not sulfur, others sulfur and bivalent iron. Temperature and pH conditions of bacterial environment produce morphologic changes in bacteria and differences in their capacity to use chemicals. — EH

Wyllie, Peter J. *See* Lambert, Ian B. 03412

Wynne, F. L. *See* Allen, J. M. 03465

03313 **Wyss, Max.** Apparent stresses of earthquakes on ridges compared to apparent stresses of earthquakes in trenches: Royal Astron. Soc. Geophys. Jour., v. 19, no. 5, p. 479-484, tables, 1970.

The apparent strain (seismic efficiency times average strain) associated with an earthquake can be estimated by comparing the spectral amplitudes of seismic waves at high frequency to those at low frequency. This information allows one to compare the relative strength of material in different source regions. The apparent strains (stresses) associated with earthquakes on ridges do not differ in the average from those associated with shallow earthquakes in trenches, which may indicate that the strength of materials and the rupture mechanism in the two source regions are the same. — Author's summary

03698 **Yacoub, Nazieh K.; Scott, James H.; McKeown, F. A.** Computer ray tracing through complex geological models for ground motion studies: Geophysics, v. 35, no. 4, p. 586-602, illus., 1970.

A computer program has been developed to study the effect of subsurface geology on body wave propagation. The program, based on ray theory and on numerical solution of Zoeppritz's equations for any angle of incidence at elastic boundaries, traces seismic rays and energy distribution through geologic models of any complexity. Models consist of rock units that are assumed to be isotropic, perfectly elastic, and homogeneous, and are two-dimensional. The ray tracing program was applied to two geologic models of the crust, more than 100 miles long, starting at a drill hole in the Nevada Test Site. Results, displayed as raypath plots and plots of amplitude of vertical displacement at the Earth's surface, graphically illustrate the strong influence of spatial distribution and elastic property variations of rock units in raypath distribution. — *from* Authors' abstract

03180 **Yang, Kyung Rin.** Atomic Energy Research Institute of Korea radiocarbon measurements I: Radiocarbon, v. 12, no. 2, p. 350-352, 1970.

03634 **Yen, Bing C.** Stability of slopes undergoing creep deformation — Errata [to paper 6675, 1969]: Am. Soc. Civil Engineers Proc., v. 96, paper 7385, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1467, 1970.

Paper 6675 was published *in* ibid., v. 95, no. SM 4, p. 1075-1096, 1969; *see* Abs. North American Geology, April 1970.

Yiu, S. K. *See* Howell, B. F., Jr. 03307

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York, D. *See* Gittins, J. 03435

03028 **Youd, T. Leslie.** Densification and shear of sand during vibration: Am. Soc. Civil Engineers Proc., v. 96, paper 7272, Jour. Soil Mechanics and Found. Div., no. SM 3, p. 863-880, illus., tables, 1970.

Shear strength reduction and density changes in confined dry, uniformly graded, granular material subjected to horizontal steady-state vibration were quantitatively investigated in a direct shear apparatus mounted on a shaker table. Ottawa sand and 100/16-in. steel balls tested were first densified to a constant volume state, then sheared while subjected to the same or less intense vibration; their constant volume void ratio densified and sheared under the same vibrational conditions. This value decreases with faster vibration and is not dependent on frequency; both the maximum and ultimate coefficients of internal friction decrease with increasing acceleration; likewise, both the interlocking and frictional components of the coefficient are reduced. An increase of normal pressure tends to counteract these vibrational effects. Behavior noted in these and previous experiments can be explained by mechanisms involving energy barrier concepts. — GDC

03626 **Youd, T. Leslie; Castle, Robert O.** Borrego Mountain earthquake of April 8, 1968: Am. Soc. Civil Engineers Proc., v. 96, paper 7396, Jour. Soil Mechanics and Found. Div., no. SM 4, p. 1201-1219, illus., tables, 1970.

The strongest earthquake to strike California in more than 15 years hit the western edge of the Imperial Valley near Borrego Mtn. on April 8, 1968. The location of the shock in a largely undeveloped area was apparently responsible for the light structural damage and absence of serious injury. A number of ground effects that have important engineering implications were observed. Tectonic ruptures along a 20-mile segment of the Coyote Creek fault were especially significant because of the unusual width and complexity of the fractured zone. Locations of individual fractures could have been closely predicted over no more than half their extent. Ground effects characteristic of Modified-Mercalli intensities of VIII-IX were observed at distances of up to 30 miles from the ruptured fault. It is inferred that intensity was governed as much by ground conditions as proximity to the epicenter. — *from* ASCE abstract

03133 **Young, Grant M.** An extensive early Proterozoic glaciation in North America,: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 7, no. 2, p. 85-101, illus., tables, 1970.

The Early Proterozoic Gowganda Formation of Ontario has long been considered to be a glacial deposit. Similar deposits of similar age occur in the Northern Peninsula of Michigan, at Fern Creek and on the north side of the Dead River Storage Basin, in the Medicine Bow Mountains of Wyoming, and at Chibougamau in northern Quebec. The wide separation of these areas indicates an extensive glaciation in Early Proterozoic times. The chemical composition of tillite matrix materials and laminated argillites from most of these areas shows a remarkable homogeneity which may reflect the homogeneous nature of a large part of the Superior craton. — Author's summary

Yuen, P. C. *See* Weaver, P. F. 03158

Zanazzi, P. F. *See* Fanfani, L. 03168

03556 **Zen, E-an.** Evaluation of thermodynamic data on pyrophyllite and their petrologic implications [abs.]: Fortschr. Mineralogie, v. 47, no. 1, p. 83-84, 1970.

03672 **Zietz, Isidore; Andreasen, Gordon E.; Cain, Joseph C.** Magnetic anomalies from satellite magnetometer: Jour. Geophys. Research, v. 75, no. 20, p. 4007-4015, illus., 1970.

A selected number of the 18,000 proton magnetometer observations made from the USSR satellite Cosmos 49 were fitted to a special field model; residual anomalies were less than 100 γ and are consistent with belts of broad anomalies known from surface and near-surface magnetic measurements. Correlation of residual anomalies with broad geologic provinces is good. A series of magnetic lows across continental United States agrees in position with a proposed rift extending from the Cape Mendocino fracture off the west coast to the wrench fault system proposed by Drake and Woodward in the east coast area. Large-amplitude lows are associated with the Basin and Ridge province and northern Rocky Mountains; both regions are characterized

by high heat flow, similar crustal structure, and Cenozoic geologic history. Central Wyoming, central Montana, and the Colorado Plateau are characterized by normal heat flow and generally positive magnetic anomalies. — DBV

Zimmerman, Herman B. *See* Dillon, William P. 03680

03089 **Zoghet, Mouine Fahed.** Alpine surface soil movement [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 10, p. 4453B-4454B, 1970.

03378 **Zohdy, Adel A. R.** Geometric factors of bipole-dipole arrays: U.S. Geol. Survey Bull. 1313-B, p. B1-B26, illus., tables, 1970.

Formulas are derived for computing the geometric factors of the azimuthal, equatorial, parallel, polar, perpendicular, and L-shaped bipole-dipole electrode arrays. The derivations are based on the assumption that a component of the electric field along the azimuthal, the parallel, or the perpendicular direction is approximately measured. For each array, the geometric factor is expressed as the product of two factors, K. and A. The factor K. is simple to compute, being expressed as (R^2/MN) for all the considered arrays where R is the bipole-dipole spacing and MN is the distance between the measuring electrodes. The expression for the factor A is complicated, and its evaluation is generally cumbersome. Nomograms, curves, and tables are given to facilitate the evaluation of various A factors with sufficient accuracy for most practical purposes. — Author's abstract

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